Appeal No. 2015-1297

United States Court of Appeals for the Federal Circuit

ULTIMATEPOINTER, L.L.C.,

Plaintiff - Appellant,

v.

NINTENDO CO., LTD.,
NINTENDO OF AMERICA INC.,

Defendants - Appellees.

Appeal from the United States District Court
for the Western District of Washington
Case No. 2:14-CV-00865-RSL
District Judge Robert S. Lasnik

PLAINTIFF-APPELLANT'S PRINCIPAL BRIEF [NONCONFIDENTIAL]

CHARLES J. ROGERS
CONLEY ROSE, P.C.
1001 MCKINNEY STREET, SUITE 1800
HOUSTON, TEXAS 77002
(713) 238-8049
Principal Attorney

GREGORY L. MAAG
THOMAS L. WARDEN
MICHAEL J. GUTHRIE
CONLEY ROSE, P.C.
1001 MCKINNEY STREET, SUITE 1800
HOUSTON, TEXAS 77002
(713) 238-8000
Of Counsel

Attorneys for Plaintiff-Appellant UltimatePointer, L.L.C.

March 30, 2015

CERTIFICATE OF INTEREST

Counsel for Plaintiff-Appellant UltimatePointer, L.L.C. certifies the following:

1. The full name of every party or amicus represented by me is:

UltimatePointer, L.L.C.

2. The name of the real party in interest represented if the party named in the caption is not the real party in interest is:

Not applicable.

3. Any parent corporation and any publicly held corporation that owns 10 percent or more of the stock of the party represented by me are:

None.

4. The names of all law firms and the partners or associates that have appeared for the party in the lower tribunal or are expected to appear in this Court are:

Conley Rose, P.C.

Charles J. Rogers
Gregory L. Maag
Thomas L. Warden
Amy E. LaValle
Michael J. Guthrie

Capshaw DeRieux, LLP

Sidney Calvin Capshaw, III
Elizabeth L. DeRieux
Daymon Jeffrey Rambin

Byrnes Keller Cromwell LLP

Bradley S. Keller

/ / /

/s/Charles J. Rogers
Charles J. Rogers
Conley Rose, P.C.
1001 McKinney Street, Suite 1800
Houston, Texas 77002-6421
Telephone: (713) 238-8049
Facsimile: (713) 238-8008
E-mail: CRogers@conleyrose.com

Principal Attorney for Plaintiff-Appellant UltimatePointer, L.L.C.

TABLE OF CONTENTS

CONFIDENTIAL MATERIALS OMITTED

The material omitted by redactions in the text on pages 4, 14, 15, 16, 50, and 54 describes the technical and operational specifications of the accused Wii Remote. The material omitted by redaction of the figures on pages 5 and 15 describes the technical specifications of the accused Wii Remote. The material omitted by redactions in the text on pages 14, 15, 17, 50, 52, 54, and 61 is a technical description of the features and operation of the accused Wii Remote from a confidential expert report. The omitted materials are indicated by green highlighting in the confidential version of this Brief.

TABLE OF AUTHORITIES

Page(s)

U.S. Supreme Court Cases

U.S. Court of Appeal Cases

District Court Cases

Statutes

TABLE OF ABBREVIATIONS

Parties

UltimatePointer	Plaintiff-Appellant UltimatePointer, L.L.C.
Nintendo	Defendants-Appellees Nintendo Co., Ltd. and Nintendo of America Corp. (collectively)

Citations

A__	Joint Appendix at page(s) __, with (column:line) for patents and with (lines) for transcripts

Terms

‘321 Patent	U.S. Patent No. 7,746,321 to UltimatePointer
‘729 Patent	U.S. Patent No. 8,049,729 to UltimatePointer
11-496 Action	Civil Action No. 6:11-CV-00496-LED (E.D. Tex.)
11-571 Action	Civil Action No. 6:11-CV-00571-LED (E.D. Tex.)
14-865 Action	Civil Action No. 2:14-cv-00865-RSL (W.D. Wash.)
CCD	Charge coupled device
CMOS	Complementary metal oxide semiconductor
Court	United States Court of Appeals for the Federal Circuit
Dkt. No.	Docket Entry Number
LED	Light emitting diode
PTO	United States Patent and Trademark Office

STATEMENT OF RELATED CASES

Pursuant to Federal Circuit Rule 47.5, UltimatePointer, L.L.C. states as follows:

(a) This civil action in the lower court was previously before this or any other appellate court only in the following appeal:

In re Nintendo Co., Ltd. et al., 544 F. App'x 934 (Fed. Cir. 2013) (nonprecedential), panel of Alan D. Lourie, Kathleen M. O'Malley, and Jimmie V. Reyna, Circuit Judges.

(b) It is not aware of any other case that will be directly affected by the Court's decision in this case, other than the following cases:

UltimatePointer, L.L.C. v. Nintendo Co., Ltd. et al., No. 6:11-CV-00496 (E.D. Tex. filed Sep. 15, 2011) ("the 11-496 Action"); and

UltimatePointer, L.L.C. v. Nintendo Co., Ltd. et al., No. 6:11-CV-00571 (E.D. Tex. filed Nov. 1, 2011) ("the 11-571 Action").

These cases have been stayed by the district court. A12631, A12648-50.

I. STATEMENT OF JURISDICTION

UltimatePointer sued Nintendo for patent infringement under 35 U.S.C. § 271. A2090-91; A19760-61. The district court had jurisdiction over UltimatePointer's infringement claims under 28 U.S.C. § 1338(a). The district court issued a final judgment on December 24, 2014. A34. UltimatePointer timely filed its Notice of Appeal on January 23, 2015. A19421-22. Accordingly, this Court has appellate jurisdiction under 28 U.S.C. § 1295(a)(1).

II. STATEMENT OF THE ISSUES

1. Whether the district court erred in construing the following claim terms:

Claim Term(s)	Claim(s)
"handheld device" and "pointing device"	'321 Patent, Claims 51 and 52; '729 Patent, Claims 1, 3, 5, 6, and 12
"image sensor"	'321 Patent, Claim 37; '729 Patent, Claims 1, 3, 5, 6, and 12
"data of the calibration points"	'729 Patent, Claims 5, 6, and 12
"directed at"	'321 Patent, Claims 51 and 52
"control data"	'321 Patent, Claims 33, 34, and 37
"first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point"	'321 Patent, Claims 51 and 52

Claim Term(s)	Claim(s)
"first calibration data related to said enclosure being directed towards said first calibration point"	'321 Patent, Claims 33, 34, and 37

2. Whether the district court erred in granting summary judgment of non-infringement for the '729 patent, including the following issues:

(a) Whether the Wii Remote in the accused Wii system is a "handheld device" under a correct claim construction, and even under the district court's erroneous "direct pointing" claim construction; and

(b) Whether the CMOS image sensor in the Wii Remote is an "image sensor" under a correct claim construction.

3. Whether the district court erred in granting summary judgment that apparatus claims 1, 3, 5, and 6 of the '729 patent were invalid as indefinite under 35 U.S.C. § 112 (2006) for including a method step.

III. STATEMENT OF THE CASE

A. Preliminary Statement

This is an appeal from a patent infringement action in which UltimatePointer asserts two patents-in-suit that claim devices for controlling a cursor on a computer screen using a handheld device. The inventor, Dr. Erik Banning, conceived of the idea for his invention while working as a research petrophysicist. A6257-58; A11591, A11594-95. In this field, Dr. Banning often observed computer-

controlled presentations where the presenter typically used a laser pointer to intuitively point at objects on the screen. A6254-55, A6257-58, A6260, A6262-63. However, when the presenter then wanted to interact with objects on the screen (e.g., click on an icon), he was forced to make an awkward switch to a traditional computer mouse. ***Id***. Dr. Banning had the idea to make a simple handheld device that would work by pointing it like a laser pointer, yet still be able to control the on-screen cursor like a mouse could do. ***Id***.; ***see also*** A8648-49, A8653-57, A8664. Dr. Banning filed a provisional patent application on May 28, 2004, A237, and formed UltimatePointer to develop and commercialize his invention.

In its Complaints filed in the 11-497 Action and in the 11-571 Action, UltimatePointer asserts claims from the two patents-in-suit against Nintendo. Nintendo makes and sells the accused Wii video game system, which includes a handheld Wii Remote, a Console (the main processor), and a Sensor Bar (which is placed on top of or below a television).

Fig. 1. Accused Wii System. A14970.

As discussed below, the district court granted summary judgment of non-infringement for the '729 patent claims based on erroneous claim constructions which led it to conclude that the handheld Wii Remote (Fig. 2 below) is not a "handheld device," and that the CMOS image sensor in the Wii Remote (Fig. 3 below), which senses [redacted][1], is not an "image sensor" as recited in the asserted claims.

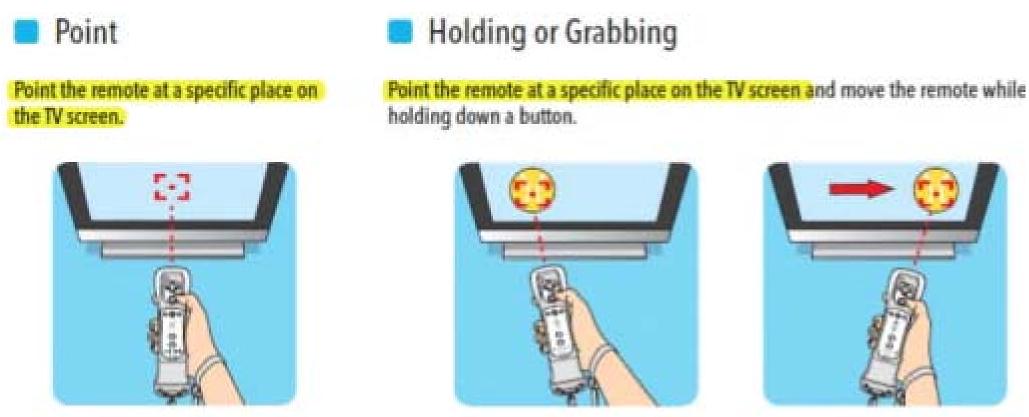


Fig. 2. Nintendo Manual Depicting Operation of the Wii Remote. A16610.

[1] A14937-39; A14942-45.

[redacted]

Fig. 3. Nintendo Document Depicting Wii Remote CMOS Image Sensor. A14886.

B. Procedural History

UltimatePointer filed its Original Complaint in the 11-496 Action on September 15, 2011. There, UltimatePointer asserted that Nintendo infringed claims of the '321 patent by making and selling Wii video game systems, Wii Remote controllers, and games. A319-20, A326-31. Upon issuance of the '729 patent on November 1, 2011, UltimatePointer filed its Original Complaint in the 11-571 Action, which similarly asserted that Nintendo infringed claims of the '729 patent by making and selling Wii video game systems, Wii Remote controllers, and games. A19703-04, A19710-14. UltimatePointer originally asserted claims 5,

Confidential Portions Omitted

6, 12, 15, 19, 20, 23, 25, 27, 31-34, 37, 44, 47, 51 and 52 of the '321 patent, and claims 1, 3, 5, 6, and 12 of the '729 patent. A2544-45; A2711-12.

In late 2012, the parties filed their proposed agreed claim constructions and their respective briefs regarding disputed claim constructions. ***E.g.***, A3023-24, A3028-31, A3033, A3044-45, A3047-50, A3053-55; A5082-83, A5086-87, A5093, A5095.

The district court held a claim construction hearing on January 17, 2013. A5647-49. On May 28, 2013, the district court issued the first of three claim constructions, including the following constructions relevant to this appeal:

Claim Term(s)	Construction
"handheld device" and "pointing device"	handheld direct-pointing device and direct-pointing device, respectively
"image sensor"	a device that measures the intensity of reflected light from an image
"data of the calibration points"	sensor data that is indicative of the relationship of the calibration points to the image
"directed at"	pointed so that the point-of-aim intersects with
"control data"	processed spatial-state data

Claim Term(s)	Construction
"first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point"	first calibration data that indicates the spatial state of the enclosure when the user input device shows that the enclosure is directed toward first calibration point
"first calibration data related to said enclosure being directed towards said first calibration point"	first calibration data representing or indicating the spatial state of the enclosure when the enclosure is being directed towards a first calibration point

A109-10. In this same ruling, the district court also granted in part and denied in part a motion for summary judgment of indefiniteness. A107-08. In response to the district court's claim constructions and summary judgment ruling, UltimatePointer withdrew its assertion of claims 5, 15, 19, 20, 23, and 25 of the '321 patent. A7033-34, A7039.

On June 6, 2013, the district court consolidated the 11-496 Action and the 11-571 Action for pretrial purposes and allowed Nintendo to proceed with an early motion for summary judgment of non-infringement for claim 47 of the '321 patent. A5918, A5921-22, A5925-27.

On October 28, 2013, the district court issued a supplemental construction of the term "spatial state" used in certain claims of the '321 patent, which the court construed as "the state of an object in space, as defined by its three-dimensional position and three-dimensional orientation." A64, A70. This supplemental construction precipitated the district court's summary judgment of non-

infringement for claim 47 of the ‘321 patent. A10315, A10323. In response to the district court’s supplemental construction and summary judgment ruling, UltimatePointer withdrew all but one of the remaining claims of the ‘321 patent, leaving claim 12 of the ‘321 patent and claims 1, 3, 5, 6, and 12 of the ‘729 patent as the only asserted claims. A10605-06; A10612-13; A35, A41.[2]

On June 17, 2014, the district court severed and transferred the claims against Nintendo to the Western District of Washington.[3] A12631, A12650-51. The district court in Washington set a trial date of January 5, 2015. A12693-94.

On September 14, 2014, UltimatePointer filed a motion for summary judgment that apparatus claims 1, 3, 5, and 6 of the ‘729 patent were not invalid as indefinite for allegedly including a method step. A13240-41, A13252-54. On the same day, Nintendo moved for a summary judgment of non-infringement with respect to all asserted claims. A13405-06. In a footnote to its response to

[2] This ruling required UltimatePointer to withdraw claims 33, 34, 37, 51, and 52 of the ‘321 patent, which are now at issue this appeal. UltimatePointer is appealing the district court’s construction of ‘321 patent claim terms to allow it to reassert these claims on remand. UltimatePointer is not appealing the district court’s construction of “spatial state” and the resulting summary judgment of no infringement for claim 47 of the ’321 patent, but is appealing the construction of the ‘321 patent claim terms “control data” and “first calibration data” to remove “spatial state” from the construction of these claim terms.

[3] The 11-497 and 11-571 Actions named as defendants Nintendo and certain retailers of the accused products. When the district court severed and transferred the claims against Nintendo to the Western District of Washington, it stayed the 11-497 and 11-571 Actions against the retailers that remained in the Eastern District of Texas. A12631, A12648-50.

UltimatePointer's motion for summary judgment, Nintendo also asked the district court to grant a summary judgment that apparatus claims 1, 3, 5, and 6 of the '729 patent were invalid as indefinite for allegedly including a method step. A15072-73, A15084 n.7.

On December 22, 2014, the district court granted Nintendo's motion for summary judgment of non-infringement and its cross-motion for summary judgment of indefiniteness. A35, A41; A56, A59-60. In its summary judgment order, the district court also ***sua sponte*** grafted a further narrowed construction of "handheld device" in the asserted claims of '729 patent. The district court narrowed the initial May 2013 construction of this limitation (a "handheld ***direct-pointing*** device") by further requiring that the device "place[] the cursor at the physical point of aim." A37. The district court also narrowed the initial May 2013 construction of "image sensor" ("a device that measures the intensity of reflected light from an image") by excluding a sensor that senses an image of LEDs. ***Id***. ("The light emitted from the LEDs is not an 'image' as that term is used in the '729 patent.").

On December 24, 2014, Nintendo stipulated to the dismissal of its last remaining counterclaims, which alleged invalidity of method claim 12 of the '321 patent and method claim 12 of the '729 patent. A16996-97. The district court then entered final judgment on December 24, 2014. A34.

C. Statement of the Facts

1. The Claimed Inventions

The ‘321 and ‘729 patents generally describe devices and methods for controlling a cursor on a computer generated image. ***E.g.,*** A237; A279. Dr. Banning’s application for the ‘321 patent was filed May 24, 2005, and claims priority to provisional applications filed on May 28, 2004 and January 18, 2005. A237. His application for the ‘729 patent was filed on May 19, 2010 as a continuation of the application for the ‘321 patent. A279.

The exemplary embodiments of Dr. Banning’s invention described in the specification and drawings include a pointing device with a handheld enclosure that houses one or more sensors that generate data used to control the cursor based on the point of aim of the pointing device. ***E.g.***, A261 (5:41-6:21) (Summary). A first embodiment measures the “position and orientation” of the pointing device. A261 (5:41-54), A261 (6:66) to A268 (19:26). The sensors may include one or more of electromagnetic tracking devices, ultrasonic tracking devices, CCDs, accelerometers, or gyroscopes. A262 (7:10-23). A second embodiment adds a distance measuring sensor, such as a digital camera. A268 (19:27-20:27).

A third embodiment measures only the orientation of the handheld device using “angles” between the pointing line and geographic reference lines, such as gravity or magnetic field lines. A261 (6:5-18), A268 (20:28) to A270 (24:57).

The third embodiment may include any of the sensors used in the first two embodiments, as well as a sensor for measuring angles with respect to geographic references, such as an accelerometer or a digital compass. A268 (20:28-32, 45-50). In this third embodiment, measuring distance, while not necessary, A269 (22:8-22), may improve accuracy, A270 (24:1-12).

To define the interaction region, where the user will point to interact with computer generated image, the foregoing embodiments make use of calibration points that have a predetermined relationship to the computer generated image. ***E.g.***, A240 (Fig. 2, reproduced below, showing points 721a-d), A266 (15:18-16:44) (two points), A266 (16:45) to A267 (18:47) (three points); A259 (21:52-55).

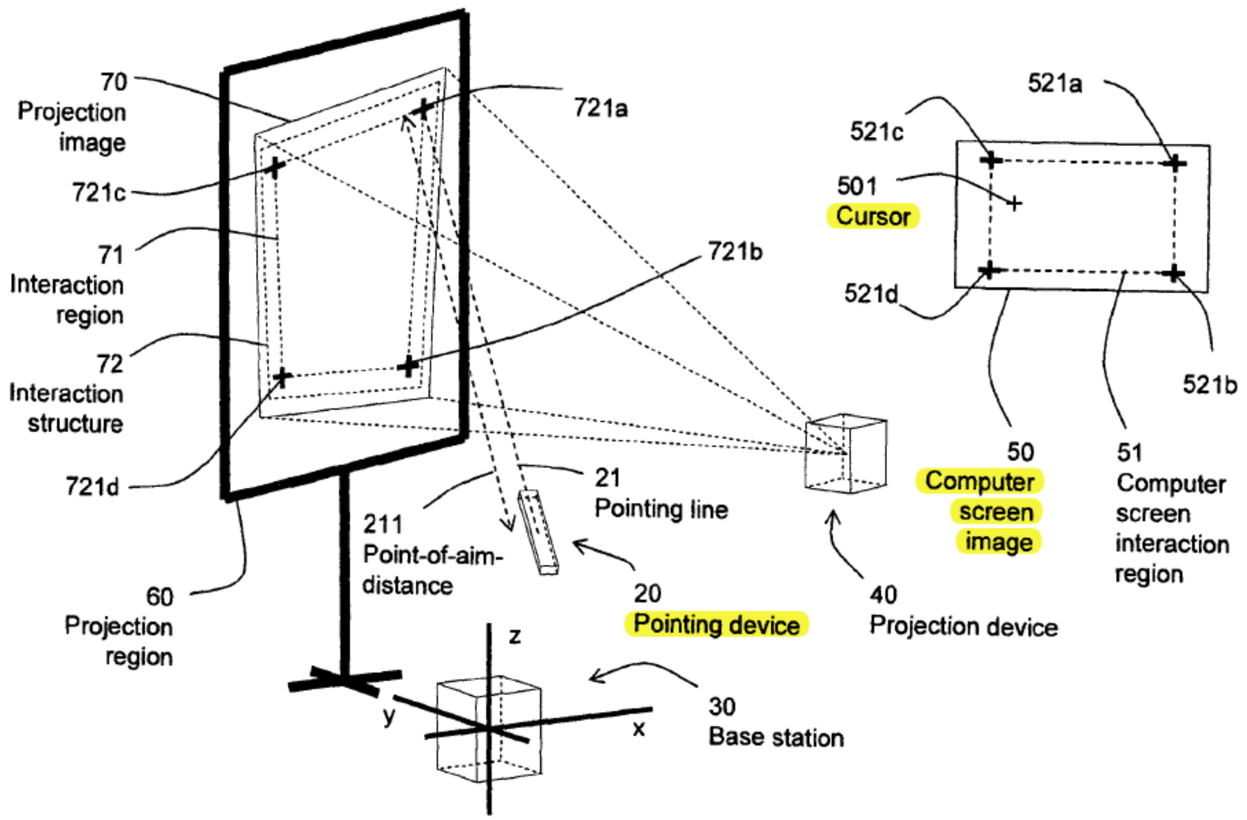


Fig. 2

Fig. 2 from U.S. Patent No. 7,746,321. A240 (highlighting added).

As noted in Part V.B.1 below, a "handheld direct pointing device" is one of the district court's claim constructions at issue in this appeal. The following is a summary of the different types of pointing devices referred to in the patents-in-suit. In discussing the prior art, the Background portion of the '321 patent describes direct pointing devices, indirect pointing devices, and pointing devices classified as neither entirely direct nor entirely indirect. The Background first notes as follows:

> Broadly speaking, pointing devices may be classified in two categories: a) devices for so-called 'direct-pointing' and b) devices for

> so-called 'indirect-pointing'. Direct pointing devices are those for which the physical point-of-aim coincides with the item being pointed at, i.e., it lies on the line-of-sight. Direct pointing devices include the so-called 'laser pointer' and the human pointing finger. Indirect pointing devices include systems where the object of pointing (e.g., a cursor) bears an indirect relationship to the physical point-of-aim of the pointing device; examples include a mouse and a trackball.

A259 (1:55-65) (emphasis added). The Background then identifies several prior art references that disclose "indirect pointing devices." The Background describes these systems as "less natural" or lacking the "intuitiveness" of "direct-pointing systems." A259 (2:1-40). The Background continues to list several prior art references disclosing "direct pointing devices." These prior "direct pointing systems" still had shortcomings: they lacked portability, required special screens, or required rooms with special equipment. A259 (2:41) to A260 (4:38). The Background then concludes by describing prior art systems classified as "other than entirely direct-pointing or indirect-pointing systems." These systems likewise had shortcomings, e.g., they were limited to two-dimensional applications or required that the screen be within reach of the operator. A260 (4:39) to A261 (5:31). Thus, the Background did not establish any clear dividing line between direct and indirect pointing devices.

2. The Accused Wii Video Game System

The accused Nintendo Wii video game system includes a Wii Console, a Wii Remote, and a Sensor Bar. A13620, A13633; ***see also*** Fig. 1 at page 3 above. The

Wii Console provides video signals to a television screen and communicates wirelessly with the Wii Remote. The Wii Remote is the primary controller for the system. A13634. Nintendo acknowledges that the Wii Remote is held in the user's hand and is used to interact with the system. ***Id***.

The Wii Remote includes a "[redacted]" positioned inside its front end, which is configured to sense LEDs located at both ends of the Sensor Bar. A13634; Fig. 3 at page 5 above; ***see also*** A14825, A14863-64, A14866, A14868, A14870; A14922, A14928, A14931, A14932 n.3 (Nintendo's expert discussing the "[redacted]"); A14942-44 (Nintendo technical document discussing the "[redacted]"); A14947, A14949 (39:19-20) (Nintendo engineer referring to the "[redacted]").

The CMOS image sensor senses [redacted] A14937-40; A14943-45. The CMOS image sensor is connected to a [redacted]. A14943. The CMOS image sensor is shown on the far left of Fig. 4 below:

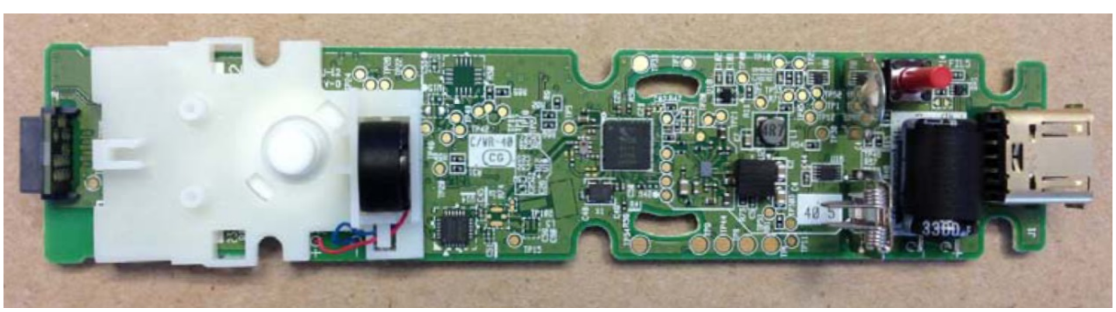


Fig. 4. Wii Remote with CMOS Image Sensor.
A14868 (reference lines omitted).

The CMOS image sensor in the Wii Remote is sensitive to infrared light emitted by the LEDs on the sensor bar. The Wii Remote also includes a filter located in front of the CMOS image sensor to help distinguish the infrared LEDs. A13635; A14940.

Nintendo refers to the CMOS image sensor and its associated processor as the "Direct Pointing Device" or "DPD." A36; Fig. 5 below. Nintendo's retained expert from past litigation involving the Wii noted that "[redacted]" A14931 (emphasis added).

[redacted]

Fig. 5. Nintendo's Block Diagram of Wii Remote "Direct Pointing Device" with "[redacted]." A14944.

Confidential Portions Omitted

The Wii Remote uses the CMOS image sensor to measure the [redacted] the infrared LEDs at either end of the Wii sensor bar. [redacted]. A14882, A14886; A14837, A14843-45; ***see also*** A14928-34 (describing operation).

The Wii Sensor Bar is placed on top of or below the television screen. Nintendo also instructs users to align the Sensor Bar with the center of the television screen. A14893; A16605-08. The Wii Console also has a setting for users to tell the Wii Console whether the Sensor Bar has been positioned above or below the television. A14838.

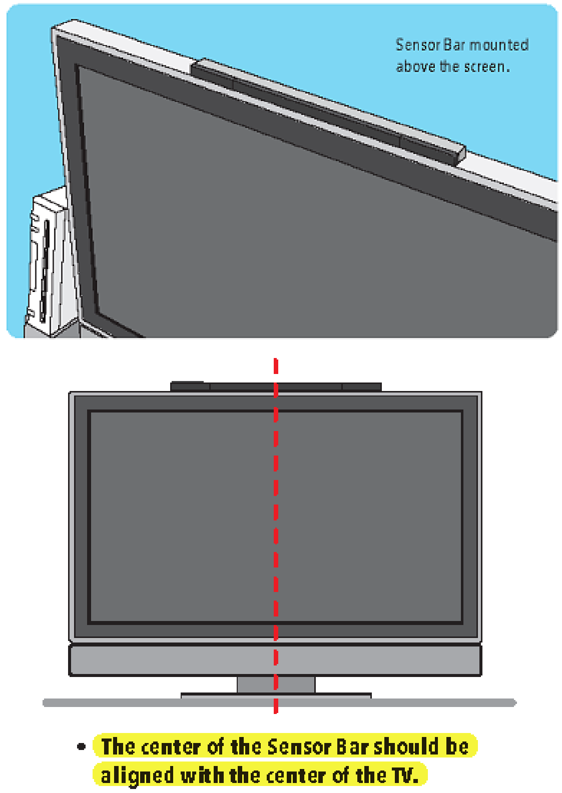


Fig. 6. Nintendo Manual Specifying Wii Sensor Bar Position. A16606-07.

To use the Wii Remote for controlling the cursor, Nintendo instructs users to operate it from "directly in front" of the television at a distance of 3-10 feet. A16609. [redacted] A14928 (emphasis added). Nintendo's manual for the Wii system specifically instructs users to point the Wii Remote at specific icons or buttons on the television screen. A14836-37; A16610 (reproduced in Fig. 2 at page 4 above); A16612-27 (figures from A16614 reproduced as Fig. 7 below).

> To select any of these activities, simply point at one with the Wii Remote and press the A Button.

. . . .

Fig. 7. Wii Menu Operation. A16614 (excerpted and reference lines omitted).

The principal screen cursor used in the Wii system is an image of a hand with the pointing finger extended, which Nintendo appropriately called the "Pointer." A14839.

Fig. 8. The Wii Cursor / Pointer. A14840.

IV. SUMMARY OF THE ARGUMENT

UltimatePointer appeals the district court's construction of claims, which improperly limited claims 1, 3, 5, 6, and 12 of the '729 patent and claims 33, 34, 37, 51, and 52 of the '321 patent. UltimatePointer also appeals the district court's summary judgments, which found no infringement of claims 1, 3, 5, 6, and 12 of the '729 patent, and found apparatus claims 1, 3, 5, and 6 of the '729 patent invalid as indefinite for claiming a method step.

As discussed in Part V.C below, the district court's claim constructions should be vacated under a ***de novo*** standard. The first construction of the broadly claimed "handheld device" and "pointing device," as requiring "direct pointing," misapplies the doctrine of specification disclaimer. The second construction requiring that a cursor appear precisely at the physical point of aim of the handheld device of further conflicts with the patent's written description.

The district court's construction of the ordinary term "image sensor" as a sensor that measures only "reflected light," is <u>wholly</u> unsupported by any potential claim construction evidence (intrinsic or extrinsic). The origin of this construction remains a mystery.

The constructions of "directed at" and "data of the calibration points" likewise conflict with both the written description and ordinary meaning. Further,

these constructions also mistakenly insert limitations found only in unrelated claims.

Finally, the constructions of "control data" and "first calibration data" likewise conflict with the ordinary meaning and insert limitations found only in unrelated claims. In the case of "first calibration data," the construction also creates a gross inconsistency with a corresponding "second calibration data" limitation found in an immediately dependent claim, which was construed as having only ordinary meaning.

As discussed in Part V.C below, the district court's summary judgment of non-infringement for claims 1, 3, 5, 6, and 12 of the '729 patent should be reversed because it rests on an erroneous conclusion that the Wii Remote is not a "handheld device," as properly construed.

Moreover, the district court's summary judgment of non-infringement should be reversed, even if the construction requiring a "handheld direct pointing device" is affirmed, because UltimatePointer presented ample summary judgment evidence, from Nintendo's technical documents, from Nintendo's expert, from UltimatePointer's experts, and from a video of the Wii system in operation, which both individually and collectively create at least genuine and material disputes regarding the "handheld device" limitation.

As is discussed in Part V.D below, the district court's summary judgment of invalidity should be reversed because it is based on erroneous conclusions that the limitations reciting "an image sensor, said image sensor generating data" include a method step. This Court and numerous district courts have properly held, in nearly identical situations, that such a limitation permissibly recites only a structural component and its corresponding function, and is therefore not a method step and not indefinite under 35 U.S.C. § 112, ¶ 2 (2006).

Accordingly, this Court should vacate the district court's erroneous claim constructions, and under correct constructions, reverse the district court's summary judgment of non-infringement and its summary judgment of indefiniteness.

V. ARGUMENT

A. Standard of Review

This Court reviews summary judgments under the law of the applicable regional circuit. ***Braintree Labs., Inc. v. Novel Labs., Inc.***, 749 F.3d 1349, 1356 (Fed. Cir.), ***cert. denied***, 135 S.Ct. 764 (2014). In the Ninth Circuit, summary judgment is reviewed under the ***de novo*** standard. ***Nigro v. Sears, Roebuck & Co.***, No. 12-57262, 2015 WL 774633, at *1 (9th Cir. Feb. 25, 2015). Thus, the court of appeals views the evidence in the light most favorable to the non-moving party to determine "'whether there are any genuine issues of material fact and whether the district court correctly applied the substantive law.'" ***Id***. (quoting ***Olsen v. Idaho***

St. Bd. of Med., 363 F.3d 916, 922 (9th Cir. 2004)). "A factual issue is genuine 'if the evidence is such that a reasonable jury could return a verdict for the nonmoving party.'" ***Nigro***, 2015 WL 774633, at *1 (quoting ***Anderson v. Liberty Lobby, Inc.***, 477 U.S. 242, 248 (1986)).

Infringement is a question of fact. ***EMD Millipore Corp. v. AllPure Techs., Inc.***, 768 F.3d 1196, 1200-01 (Fed. Cir. 2014). Thus, "a court may determine infringement on summary judgment when no reasonable jury could find that every limitation recited in the properly construed claim either is or is not found in the accused device." ***Id***. at 1201 (internal quotations omitted). The infringement inquiry depends on a proper construction of the claims. ***Cybor Corp. v. FAS Techs., Inc.***, 138 F.3d 1448, 1454 (Fed. Cir. 1998) (en banc).

Invalidity based on indefiniteness is a question of law that is reviewed on summary judgment under the ***de novo*** standard. ***Halliburton Energy Services, Inc. v. M-I LLC***, 514 F.3d 1244, 1249 (Fed. Cir. 2008); ***Hoffer v. Microsoft Corp.***, 405 F.3d 1326, 1328 (Fed. Cir. 2005). Indefiniteness is also a "matter of claim construction," and the same principles that generally govern claim construction are applicable to determining whether a claim is allegedly indefinite. ***Praxair, Inc. v. ATMI, Inc.***, 543 F.3d 1306, 1319 (Fed. Cir. 2008).

This Court also applies ***de novo*** review to a district court's ultimate construction of patent claims, as well as to any underlying findings based on

intrinsic evidence. ***Teva Pharm. USA Inc. v. Sandoz, Inc.***, 135 S.Ct. 831, 841 (2015). Any underlying factual issues based on extrinsic evidence are reviewed for clear error. ***Fenner Investments, Ltd. v. Cellco Partnership***, No. 2013–1640, 2015 WL 570730 at *2 (Fed. Cir. Feb. 12, 2015) (citing ***Teva Pharm***., 135 S.Ct. at 835, 841).

B. The District Court Erred In Its Constructions Relevant to Claims 1, 3, 5, 6, and 12 of the '729 Patent, and Claims 33, 34, 37, 51, and 52 of the '321 Patent

As discussed below, UltimatePointer respectfully requests that this Court vacate the district court's construction of certain claim terms from the asserted claims of the '729 and '321 patents.[4]

1. "Handheld Device" and "Pointing Device"

The Texas district court first erred in construing the ordinary terms "handheld device" and "pointing device" by importing a "direct-pointing" requirement that does not appear in any of the claims. The Washington district court then compounded this error in its summary judgment ruling by grafting an additional construction that "direct-pointing" requires the screen cursor to appear precisely at the point of aim.

4 The claim construction errors addressed in Part V.B are material to this appeal and not harmless because they were either at issue in the district court's summary judgments, A59-60; A35-39, or caused UltimatePointer to withdraw asserted claims 33, 34, 37, 51, and 52 of the '321 patent.

The term "handheld device" appears in claims 1, 3, 5, 6, and 12 of the '729 patent. For example, claim 5 recites an "apparatus for controlling a feature on a computer generated image, . . . comprising: a handheld device including . . . an image sensor[.]" A317 (34:27-33) (emphasis added).

The term "pointing device" appears in claims 51 and 52 of the '321 patent. Independent claim 51 (a ***Beauregard*** claim) recites in relevant part, "a . . . user input device to indicate that the pointing device is directed at a point." A278 (40:14-19) (emphasis added).

a) Direct Pointing

The district court construed the term "handheld device" as a "handheld ***direct pointing*** device" and the term "pointing device" as a "***direct*** pointing device." A76-77 (emphasis added).[5] The district court reasoned as follows:

> The specification characterizes the invention as a whole as a direct-pointing system that improves upon both indirect-pointing devices and prior direct-pointing devices. Subsequently, the specification refers to the system as a "direct-pointing device." The patent contemplates indirect pointing only when direct pointing is "not possible or not desired," for example, when the pointing device is out of range of the base station or too far from where it was calibrated. In such cases, indirect pointing may be used "as described in the cited prior art."

[5] UltimatePointer had proposed construing "handheld device" as "a piece of equipment or system component intended to be held in the user's hand," and "pointing device" as "a piece of equipment or system component that is intended for use as a pointer." A74-75.

> Thus, although the specification mentions indirect pointing, it is clear that the invention is aimed at direct pointing.

A76. However, the district court did not cite to, rely on, or resolve any disputes as to extrinsic evidence. A76-77. Thus, the district court's claim construction should be reviewed ***de novo***. ***Pacing Techs., LLC v. Garmin Int'l, Inc.***, 778 F.3d 1021, 1023 (Fed. Cir. 2015) (reviewing claim construction and summary judgment ***de novo***).

In ***Pacing Technologies***, this Court explained as follows:

> The specification and prosecution history compel departure from the plain meaning in only two instances: lexicography and disavowal. The standards for finding lexicography and disavowal are "exacting." To act as a lexicographer, a patentee must "clearly set forth a definition of the disputed claim term" and "clearly express an intent to define the term." Similarly, disavowal requires that "the specification [or prosecution history] make[] clear that the invention does not include a particular feature."

778 F.3d at 1024 (emphasis added) (alterations original) (quoting, e.g., ***GE Lighting Solutions, LLC v. AgiLight, Inc.***, 750 F.3d 1304, 1309 (Fed. Cir. 2014); ***Thorner v. Sony Computer Entm't Am. LLC***, 669 F.3d 1362, 1365 (Fed. Cir. 2012)). In the present case, the district court's construction did not result from lexicography or a disavowal made during prosecution. A74-77. Nor did it result from a disavowal in the specification. Rather, the district court simply substituted its own view of the "gist" of the invention based on its selective reading and interpretation of the specification. A76 (determining that, "although the

specification mentions indirect pointing, it is clear that the invention is aimed at direct pointing) (emphasis added). Correctly framed, the issue is whether the inventor made a clear disavowal in the specification.

In this respect, the district court's analysis is flawed. Here, the district court pointed out that the Background of the Invention describes several prior art "indirect pointing" devices. A76 (citing '321 patent, A259 (2:1-38)). The Background further suggests that these "indirect pointing" systems "do not provide the speed and intuitiveness afforded by direct-pointing systems." A259 (2:38-40). The district court also noted that embodiments in the written description were described as using a "direct-pointing device." A76. The district court thus viewed the invention as described in the specification as "aimed at direct pointing." ***Id***.

The critical flaw in the district court's logic is that, while specific embodiments may appear "aimed" at direct pointing, nowhere does the written description disclaim or disavow any type of a handheld device or pointing device. Disclaimer or disavowal requires that the specification include "expressions of manifest exclusion or restriction, representing a clear disavowal of claim scope." ***Epistar Corp. v. Int'l Trade Comm'n***, 566 F.3d 1321, 1334 (Fed. Cir. 2009) (citations omitted) (emphasis added). At several places in his patents, Dr. Banning used the terms "direct pointing" and "indirect pointing," and even "pointing" that is neither entirely "direct" nor "indirect." However, he did not use any of these

terms in a manner to express manifest exclusion or restriction, representing a clear disavowal of claim scope. And when it came time to define his invention in the claims, Dr. Banning certainly could have used any of these terms in his claims, but he did not do so, not as filed, A3406-07, nor as issued, A275 (33:38) to A278 (40:49); A317 (33:62) to A318 (36:24).

Thus, the district court's "direct pointing" construction boils down to a classic case of importing a particular limitation that is found only in the written description. Simply describing embodiments in the written description as using "direct pointing" does not thereby disclaim or disavow the ordinary meaning of the claim terms "handheld device" and "pointing device." ***See, e.g., In re Am. Acad. of Sc. Tech Ctr.***, 367 F.3d 1359, 1369 (Fed. Cir. 2004) ("We have cautioned against reading limitations into a claim from the preferred embodiment described in the specification, even if it is the only embodiment described, absent clear disclaimer in the specification. ") (citing, e.g., ***Liebel-Flarsheim Co. v. Medrad, Inc.***, 358 F.3d 898, 906 (Fed. Cir. 2004) ("Even when the specification describes only a single embodiment, the claims of the patent will not be read restrictively unless the patentee has demonstrated a clear intention to limit the claim scope using 'words or expressions of manifest exclusion or restriction.'").

For example, in ***Golight, Inc. v. Wal-Mart Stores, Inc.***, 355 F.3d 1327 (Fed. Cir. 2004), this Court held that because the patentees did not clearly provide a

definition or disavow any claim scope in the specification, the claim term "horizontal drive means for rotating said lamp unit in a horizontal direction" was not limited to horizontal rotation through 360° even though the patentees described their invention in the specification as having "a motor driven horizontal drive mechanism for rotating the lamp unit in a horizontal direction through at least 360°." 355 F.3d at 1330-31. The Court reasoned that because claims do not need to capture every important or significant feature described in the specification, such that it would be improper to limit the asserted claim to the 360° embodiment without a "clear disclaimer of the particular subject matter." ***Id***. at 1331 (emphasis added).

b) Exact Cursor Placement

In its summary judgment ruling in December 2014, the Washington district court compounded the error in construing "handheld device" and "pointing device," by requiring that the device actually "place[] the cursor at the physical point of aim." A37. Although the Washington district court cites no evidence for this even narrower construction, it appeared to reason that such a construction was "described by the patents" and/or by the Texas district court. A36. Neither is correct.

At the January 17, 2013 claim construction hearing in Texas, counsel for both parties acknowledged that, even in the preferred embodiments, direct-pointing

would still encompass discrepancies between the handheld's physical point of aim and the computed location of the cursor. A5766 (39:9-12), A5767 (40:9) to A5773 (46:10), A5775 (48:24) to A5776 (49:5),[6] A5778 (51:13) to A5784 (57:11), A5788 (61:5-10). The Texas district court then asked Nintendo's counsel how "direct pointing" should be defined. A5773 (46:11-14). In response, Nintendo's counsel suggested that the issue whether a device was considered a "direct pointing device" would be a matter for expert testimony. A5773 (46:15-24), A5774 (47:19-20), A5776 (49:12-20) (Nintendo's counsel arguing, e.g., that "direct pointing" has "a well-understood meaning, and the experts may agree, of what 'direct pointing' actually is"); A5777 (50:18-20) (Nintendo's counsel noting that "it may be a battle of experts as to how close it has got to be"). Nintendo's counsel also rejected the Texas district court's proposal to define what is meant by "direct pointing." A5784 (57:12) to A5786 (59:2); A5789 (62:15) to A5790 (63:12). The Texas district court thus considered, but ultimately declined to define "direct pointing," leaving it as a factual matter for trial. A76-77.

A year and a half later, without explanation and contrary to Nintendo's earlier claim construction arguments, the Washington district court ***sua sponte***

---

6 "THE COURT: . . . Is defendant arguing that 'direct pointing' means that it has to hit exactly the point? [Nintendo's Counsel]: No, Your Honor, defendant is not arguing that it has got to be absolutely — if there is a point on this wall there and I am holding a laser pointer on it, that I have to at all times hit that exact point." (Emphasis added).

defined “direct pointing” to require that the device “place[] the cursor at the physical point of aim.” A37. This narrowed construction was erroneous because, as Nintendo’s counsel acknowledged, even with respect to the preferred embodiments, the concept of “direct pointing” involves certain inaccuracies or imprecision that cause a discrepancy between the cursor location and the physical point of aim.

When the inventor summarized how “direct” and “indirect” pointing devices may be classified, he noted that “[d]irect pointing devices are those for which the physical point-of-aim coincides with the <u>item being pointed at</u>, i.e., it lies on the line-of-sight.” A259 (1:57-60) (emphasis added). He gave examples of a laser pointer and a human pointing finger. ***Id.*** Obviously, he did not thereby suggest that all direct pointing devices place a computer-generated cursor precisely at the physical point-of-aim. Logically, users point at desired features on a screen, e.g., a portion of presentation, icons, or menu items. A259 (1:40-43), A272 (28:36-45). A cursor location is <u>computed</u> based on sensor data; that computed location is not the “item being pointed at.” Put another way, a human pointing finger may be “pointed at” a spot across the room, even though the physical point of aim may not coincide with the spot.

This distinction is significant because, as discussed during the claim construction hearing, inherent imprecision and inaccuracies, assumptions about the

environment, and human errors can all cause deviations between the physical point of aim and the calculated cursor location. These deviations may result from sensor errors, differences between the actual and assumed position and shape of the interaction region, and from averaging or filtering hand movements. A265 (14:64) to A266 (15:10), A270 (24:3-5, 19-30), A272 (28:57) to A273 (29:6), A273 (29:20-26), A256 (Fig. 18). To account for these inherent discrepancies, the '321 patent expressly instructs that "visual feedback provided by the displayed cursor . . . during use of the system as a direct-pointing device will still afford the user the perception that direct-pointing is being performed." A270 (24:19-30) (emphasis added); ***see also*** A265 (14:64) to A266 (15:10) (noting similarly). The district court erroneously ignored this teaching in its summary judgment decision, where it appeared to suggest just the opposite: that adjusting the location of the cursor using "visual feedback" would not be direct pointing. A37.

To the extent any construction of "handheld device" or "pointing device" is necessary, UltimatePointer appropriately proposed an ordinary meaning (respectively, a "piece of equipment or system component intended to be held in the user's hand" and a "piece of equipment or system component that is intended for use as a pointer). A3028-29.

2. "Image Sensor"

The Texas district court first erred by narrowly construing the claim term "image sensor" by requiring that it measure the intensity of reflected light from an image. The Washington district court then compounded this error by excluding an "image sensor" that senses an image of LEDs.

During the original claim construction proceedings, UltimatePointer had proposed that an "image sensor" be construed with its ordinary meaning as a "sensing device able to capture an image." A5182, A5194; A3488, A3491 ¶ 9; A3493. Nintendo had proposed "a device that senses data from an image." ***Id***. Thus, the sole dispute was whether an "image sensor" must sense an image or whether it need only provide some data from an image. UltimatePointer and Nintendo both submitted extrinsic evidence to support their proposed constructions. A3053-55; A3488-91; A5095; A4068, A4101-03. However, the district court did not cite or rely on any extrinsic evidence. A97-98.

In its original claim construction, the Texas district court construed "image sensor" as "a device that measures the intensity of reflected light from an image." A98. However, this construction is not supported by any intrinsic or extrinsic evidence. In its analysis, the district court pointed out the "digital cameras" and "CCD" sensors referred to in the written description. ***Id***. However, it viewed the '321 patent as distinguishing between a CCD sensor for sensing coordinates and a

digital camera for capturing images. ***Id***. The district court thus viewed the claim term "image sensor" as referring to CCDs, but not digital cameras. ***Id***. Then, without any potential factual basis (intrinsic or extrinsic) the district court described a CCD as "sens[ing] an image by focusing light reflected from an object forming the image onto a detector and measuring the intensity of the light across the imaged area." ***Id***. (emphasis added). On this mysterious basis, it construed "image sensor" as "a device that measures the intensity of reflected light from an image." ***Id***. (emphasis added). The Washington district court would later hold that this construction requires a device that measures the intensity of only reflected light. A37-38.

The term "image sensor" appears in claims 1, 3, 5, 6, and 12 of the '729 patent, and claim 37 of the '321 patent. The exact term "image sensor" is not used in the written description. In claim 1 of the '729 patent, the recited function of the "image sensor" is to generate data related to the distance between a first point and a second point. A317 (33:65-67). In claims 5 and 12 of the '729 patent, the function is to generate data including data of calibration points. A317 (34:32-33), A318 (36:1-2). Likewise, in claim 37 of the '321 patent, the function of the "image sensor" is to provide data related to the handheld enclosure being directed towards a calibration point and a non-calibration point. A277 (37:30-31, 39-43), A277 (38:5-8).

As noted by the district court, the written description of the ‘321 patent discusses both CCD sensors and digital cameras. However, there is nothing in the written description to suggest that Dr. Banning disclaimed or disavowed either a CCD or a digital camera as the claimed “image sensor.” For example, the written description refers to a digital camera as a type of sensor for generating data related to distance. A268 (19:27-55). The written description also refers to a “CCD” sensor or “image capturing device, such as a digital camera” as examples of a sensor for generating data of calibration points. A262 (7:18-21), A273 (29:7-32), A273 (30:20) to A274 (31:15). Nothing in the specification disclaims or disavows any particular sensor from being an “image sensor.”

The ‘321 patent refers to both CCD sensors and digital cameras interchangeably because a CCD sensor is simply a common type of image sensor used in digital cameras, as is a CMOS sensor. A3493 (noting that an “image sensor . . . is used mostly in digital cameras” and is “typically” a CCD or CMOS sensor); A3494-95 (depicting cameras based on CCD and CMOS sensors); ***see also*** A3488-91 (“In a familiar example, CCD and CMOS devices are the sensors in digital cameras.”).

In addition, there is simply no intrinsic or extrinsic evidence to suggest that an image sensor of any type measures the intensity of reflected light, in contrast to measuring the intensity of all light. ***See*** A98 (citing nothing to support a “reflected

light" construction). The record evidence of ordinary meaning does not make any such distinction. A3493 (noting that an "image sensor is a device that converts an optical image into an electric signal"); A3494-95 (noting that "CCD sensor elements are basically tiny capacitors that collect charge directly proportional to the amount of light that strikes the sensor"); A3488-91 (expert declaration that CCD and CMOS devices convert the energy in light into many distinct electrical signals"); ***see also*** A19377, A19380 (noting that image sensors do not distinguish between reflected and emitted light). Accordingly, the district court's construction requiring the measurement of only "reflected" light is plainly erroneous.

Even if the Texas district court's erroneous statement of how CCD sensors function is viewed as a type of factual finding, and even if viewed as based on some unknown extrinsic evidence, the lack of any supporting extrinsic (or intrinsic) evidence still requires that this Court reject such a putative finding. Ordinarily, a "finding is clearly erroneous when, although there is evidence to support it, the reviewing court on the entire evidence is left with the definite and firm conviction that a mistake has been committed." ***Gayloard v. U.S.***, 777 F.3d 1363, 1367 (Fed. Cir. 2015) (internal quotations and alterations omitted). However, "[w]hether dealing with an issue of law like claim construction or an issue of fact such as infringement, this court must be furnished 'sufficient findings and reasoning to permit meaningful appellate scrutiny.'" ***OSRAM Sylvania, Inc. v.***

American Induction Tech., Inc., 701 F.3d 698, 707-09 (Fed. Cir. 2012) (quoting, e.g., ***Nazomi Commc'ns, Inc. v. Arm Holdings, PLC***, 403 F.3d 1364, 1371 (Fed. Cir. 2005)). Thus, a finding of fact will be considered to be clearly erroneous if it is "implausible in light of the record, viewed in its entirety, or if the record contains <u>no evidence</u> to support it." ***National Wildlife Federation v. National Marine Fisheries Serv.***, 422 F.3d 782, 794 (9th Cir. 2005) (emphasis added) (citations omitted) (citing, e.g., ***Buffalo v. Sunn***, 854 F.2d 1158, 1165 (9th Cir. 1988) ("There is simply no way in which we can assess on appeal the merits of the personal knowledge of the district judge.").

The Washington district court likewise erred when it further narrowed the already erroneous construction of "image sensor" by excluding a sensor that senses an image of LEDs. A37-38. Much like the Texas district court's failure to support its "reflected light" construction, the Washington district court also failed to explain its rationale or cite any support in the record. ***Id.*** Here, the ordinary meaning of "image" — a visual representation of something — does not exclude a sensor that senses an image of LEDs. A3489-90 (summarizing dictionary definitions). More importantly, the patents-in-suit do not attempt to either redefine the term "image," disavow images of LEDs, or use the term "image" in any unusual sense. ***E.g.***, A298 (Fig. 18); A303 (6:66-67) (referring to Fig. 18 as an "image of [a] calibration point and light spots"); A273 (29:15-16) (same); A273

(29:7-9) ("image capturing device, such as a digital camera"); A273 (30:58-61) ("image processing software"); A273 (30:66) ("digital camera may image the calibration point"). In short, the Washington district court had no basis to exclude an image sensor that senses an image of LEDs, or to otherwise limit the ordinary meaning of the claimed "image sensor."

3. "Directed At"

The Texas district court erred in construing the ordinary claim term "directed at" in a limitation reciting a handheld "pointing device" that is "directed at" a point, to require that a pointing line of the pointing device ***intersect*** the point.

Claim 51 of the '321 patent recites in relevant part:

> A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld enclosure which has a sensing device which provides sensor data and a user input device to indicate that the pointing device is <u>directed at</u> a point[.]

A278 (40:14-19) (emphasis added). The district court construed "directed at" as "pointed so that the point-of-aim intersects with." A81. UltimatePointer had proposed simply "pointed at." A80.

The district court's entire rationale for its construction is as follows:

> The claim language specifies that a sensing device is generating data indicative of a <u>spatial state</u> "while the <u>pointing line</u> is directed at a first calibration point." ['321 patent at] 38:61-62. Thus, for the data

> to be generated, the pointing line must intersect with the calibration point.

A81. The district court erred because neither the ordinary meaning of this term nor the specification mandates such a restrictive construction.

First, claim 51 does not even recite a "pointing line" as was used by the district court as a basis for its construction. Nor does claim 51 recite "spatial state" as used in the district court's reasoning. A278 (40:14-31). These terms only appear in unrelated claims. A276 (35:52-55) (Claim 15 reciting "pointing line" and "spatial state"), A277 (38:57-62) (Claim 44 reciting same), A278 (39:20-25) (Claim 47 reciting same).

Second, the ordinary meaning of "directed at" in the context of a "handheld enclosure" implies that the handheld device be "pointed at" or "pointed towards." A3141-42, A3155; A3243-44, A3255-56; A3033 (summarizing definitions of verb "direct").

Lastly, even if claim 51 had recited such a "pointing line," the written description specifically describes embodiments where the pointing line does <u>not</u> intersect a calibration point. A270 (24:19-30) (describing acceptable deviations in pointing at calibration points); A273 (29:20-32) (referencing Fig. 18 reproduced below and describing the use of a point of aim that misses the calibration point).

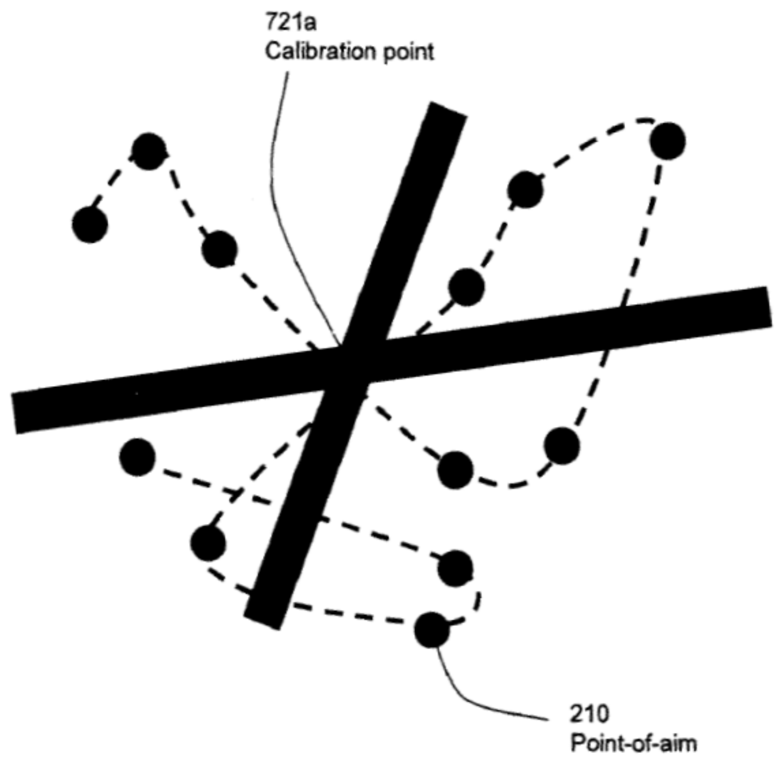


Fig. 18

Fig. 18 from U.S. Patent No. 7,746,321. A256.

Accordingly, the district court's construction of "directed at" from claim 51 of the '321 patent is erroneous and should be vacated. The correct construction is simply "pointed at."

4. "Data of the Calibration Points"

The district court construed the claim term "data of the calibration points" from claims 5 and 12 of the '729 patent as "sensor data that is indicative of the relationship of the calibration points <u>to the image</u>." A94 (emphasis added). This construction is erroneous because data of calibration points generated by an image

sensor in a handheld device only indicates the relationship of the calibration points to the handheld device.

Claims 5 and 12 of the '729 patent both recite "calibration points provided in a predetermined relationship to the image." A317 (34:28-29), A318 (35:25-26). The claims then recite a handheld device with an image sensor that generates "data of the calibration points" for use in controlling a feature on the image. A317 (34:31-38), A318 (36:1-4). UltimatePointer's proposed construction was simply "data generated from detecting the calibration points." A93.

In support of its construction, the district court reasoned as follows:

> The claims recite that there are "calibration points provided in a predetermined relationship to the [computer generated] image." Thus, the term "data of the calibration points" carries the **plain meaning** of "data that is indicative of the relationship of the calibration points to the image." Furthermore, the claims clearly specify that the data of the calibration points is provided by a sensor. Therefore, "data of the calibration points" is construed as "sensor data that is indicative of the relationship of the calibration points to the image."

A94 (emphasis added). Quite aside from the fact that there was no intrinsic or extrinsic evidence of such a "plain meaning," the flaw in the district court's logic is that "data of the calibration points" from an image sensor in the handheld device is certainly "indicative of the calibration points," but it has no bearing on the relationship of the calibration points to the image.

For example, the written description of the '729 patent notes that data from a "CCD" image sensor may provide data related to the position and orientation <u>of the handheld device</u>. A304 (7:8-42). Data from a "digital camera" that captures images of the calibration points may likewise be used to estimate the position and orientation <u>of the handheld device</u>. A315 (29:37-49). Conversely, if the position and orientation of the handheld device are known, a digital camera may be used to help determine the position <u>of the calibration points</u>. A315 (30:65) to A316 (31:31). Quite logically, at no place does the '729 patent suggest that data from an image sensor indicates the relationship between the calibration points <u>and the computer generated image</u>.

On the contrary, claims 5 and 12 specify that the relationship between the calibration points and the image is "predetermined." A317 (34:28-29), A318 (35:25-26). As shown in Figure 2 (reproduced below), calibration points 721a-d coincide with projected versions of screen marks 521a-521d. A305 (9:27-41). Either the <u>computer</u> places the calibration points at predetermined locations, or the calibration points are <u>specified</u> as predetermined screen locations, e.g., the corners or the center of the screen. A305 (9:34-41), A306 (12:32-38), A307 (13:10-17), A308 (16:10-14), A314 (28:6-11), A316 (31:14-24).

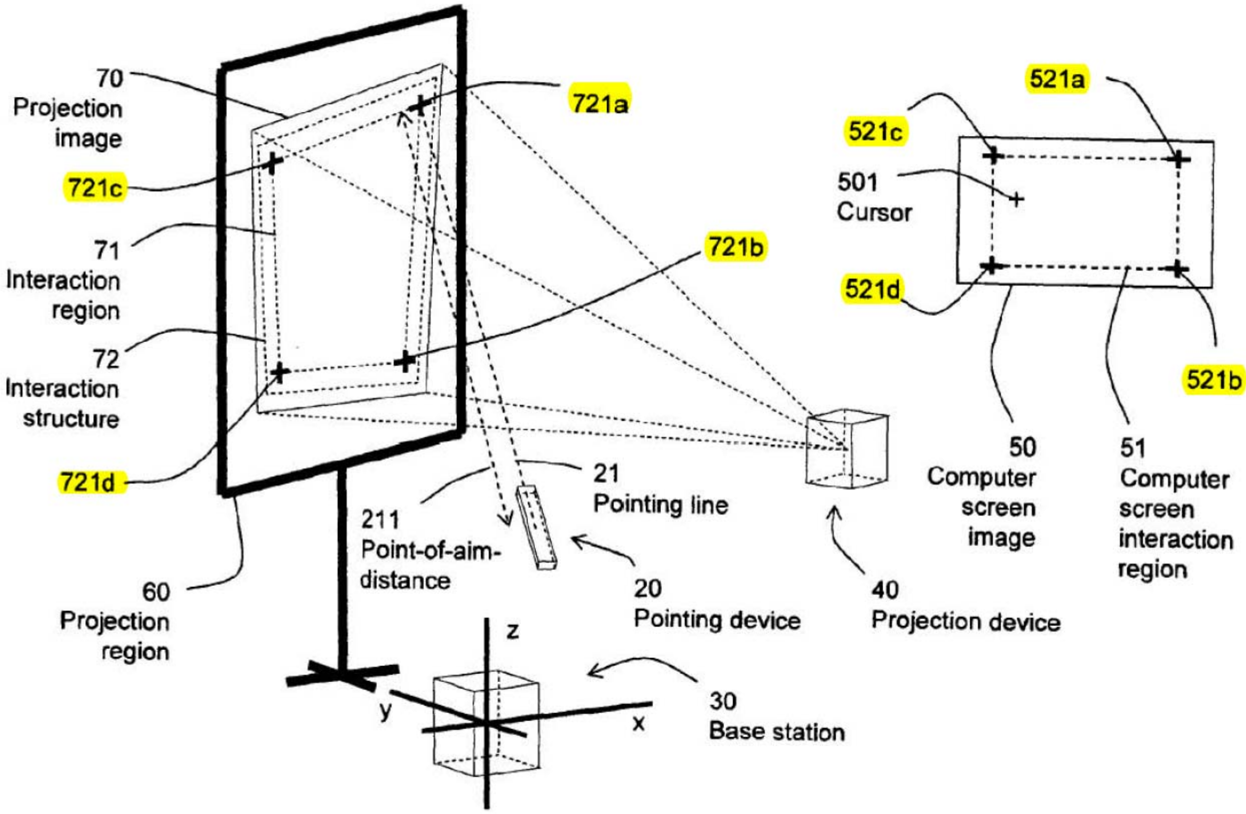


Fig. 2

Fig. 2 from U.S. Patent No. 8,049,729. A282 (highlighting added).

Accordingly, the district court's construction of "data of the calibration points" is erroneous and should be vacated. If a construction is needed, this Court should adopt UltimatePointer's proposed construction: "data generated from detecting the calibration points." A93.

5. "Control Data" and "First Calibration Data"

The Texas district court erred in construing the claim term "control data" from claims 33, 34, and 37 of the '321 patent as "processed spatial state data." A92 (emphasis added). The district court similarly erred in construing the claim

term "first calibration data" from claims 33, 34, 37, 51, and 52 of the '321 patent as "data representing or indicating the <u>spatial state</u> of the enclosure. A89 (emphasis added). These constructions are erroneous because the district court overlooked the fact that, while other claims of the '321 patent do recite such a "spatial state" limitation, claims 33, 34, 37, 51, and 52 do <u>not</u> recite it. The district court expressed no potential reason to insert this term into a construction of claims 51 and 52.

a) "Control Data"

Claim 33 of the '321 patent, from which claims 34 and 37 depend, recites as follows:

> 33. An apparatus for controlling a feature on an image generated by a computer, comprising:
>
> a handheld enclosure including a <u>sensing device which provides data</u>;
>
> a user input device to indicate that said enclosure is being directed towards a first calibration point, said first calibration point having a predetermined relation to the image; and
>
> a processor coupled to said sensing device and said user input device and programmed to provide <u>**control data**</u> for controlling the feature on the image, said processor using <u>data provided by said sensing device to develop first calibration data</u> related to said enclosure being directed towards said first calibration point and <u>noncalibration data</u> related to said enclosure being directed towards a non-calibration point, said processor further using said <u>first calibration data</u> and said <u>non-calibration data</u> to develop said <u>**control data**</u>.

A277 (37:28-45) (emphasis added). In sum, the sensing device provides "data," this sensor data is used to develop "first calibration data" and "non-calibration data," and this first calibration data and non-calibration data is used to develop "control data" for controlling a feature on the image.

In its claim construction order, the Texas district court first reasoned that "control data" is not the "raw" data provided by a sensor. A92. UltimatePointer does not take issue with the district court's basic premise that "control data" is <u>processed data</u> from the "sensing device."

However, the Texas district court also limited "control data" to "processed spatial state data." ***Id***. Here, the district court mistakenly assumed that all of the claims reciting a form of "control data" (claims 15, 19, 20, 23, 25, 33, 34, and 37 of the '321 patent) also recite underlying "spatial state data." ***Id***. (suggesting that "the claims distinguish between 'control data' and 'spatial state' data"). However, whereas claims 15 (and dependent claims 19, 20, 23, and 25) do in fact recite an underlying limitation "data indicative of a . . . spatial state," claim 33 (and dependent claims 34 and 37) do not recite "spatial state" <u>at all</u>. A276 (35:54-55) (claim 15 reciting "a sensing device for generating first data indicative of a first <u>spatial state</u> of said enclosure") (emphasis added); ***cf.*** A277 (37:28-55) (claim 33 reciting that the "sensing device . . . provides data" used to "develop first calibration data related to said enclosure being directed towards said first

calibration point"). Thus, while the district court would have been correct to construe "control data" in claims 33, 34, and 37 as "processed data from the sensing device," the district court erred by adding a "spatial state" requirement that is recited only in other claims. ***See, e.g., Comark Commc'ns, Inc. v. Harris Corp.***, 156 F.3d 1182, 1187 (Fed. Cir. 1998) ("'There is presumed to be a difference in meaning and scope when different words or phrases are used in separate claims.'") (quoting ***Tandon Corp. v. United States Int'l Trade Comm'n***, 831 F.2d 1017, 1023 (Fed. Cir. 1987)).

b) "First Calibration Data"

The Texas district court's error in overlooking differences among the claims with respect to "control data" becomes even more apparent by examining its erroneous construction of the "first calibration data . . ." limitations in claim 33 and 51 of the '321 patent. Here, the district court made the same error as it did in construing "control data."

As shown above, claim 33 recites "first calibration data related to said enclosure being directed towards said first calibration point." In relevant part, claim 51 similarly recites as follows:

> 51. A computer-readable medium or media storing computer-executable instructions for . . . a method . . . comprising:
>
> determining first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration

> point, said first calibration point having a predetermined relation to the image, based on received sensor data[.]

A278 (40:14-25) (emphasis added). The district court addressed these "first calibration data . . ." limitations from claims 33 and 51 together with certain "first data" and "first calibration data" limitations in claims 15 and 27 of the '321 patent. A87-89; A276 (35:54-56) (claim 15 reciting "first data indicative of a first spatial state") (emphasis added); A276 (36:40-41) (claim 27 reciting first calibration data indicative of a first spatial state") (emphasis added). Much like it did with respect to the "control data" limitations, the district court ignored that claims 33 and 51 simply do not recite "spatial state.

During claim construction proceedings, UltimatePointer proposed that no construction was necessary for the "first calibration data . . ." limitations from claims 33 and 51. A88. This was because the parties had proposed separate constructions for the "calibration data" and "calibration point" terms which make up the "first calibration data . . ." limitations. A3045. UltimatePointer opposed grafting Nintendo's proposed "spatial state" language into this construction because neither the claims nor the specification required full "spatial state" data. A5092.

Nonetheless, the district court included "spatial state" in its construction, apparently because it only considered the language of claim 27, which actually

recites "spatial state," whereas claims 33 and 51 do <u>not</u> recite "spatial state." A88 (citing A276 (36:37-53), [sic] A277 (38:46-51)).

Finally, the district court's error including "spatial state" in the construction of "first calibration data . . ." from claims 33 and 51 is critically underscored by the net result of such a construction. Dependent claims 34 and 52 recite "<u>second</u> calibration data . . ." limitations that are practically ***identical*** to the respective "<u>first</u> calibration data . . ." limitations from claims 33 and 51. A277 (37:52-54), A278 (40:34-36) (emphasis added). Yet, while this "first calibration data" limitation in claims 33 and 51 carries a tortured "spatial state" construction, as a result of the district court's erroneous construction, including a requirement for 3-D position and 3-D orientation, A70, this same limitation in claims 34 and 52 carries only its <u>ordinary meaning</u>, A109-10. In short, the district court had no sound basis to depart from this ordinary meaning for the "first calibration data . . ." limitations in claims 33 and 51 of the '321 patent, as proposed by UltimatePointer.

C. The District Court Erred in Granting Summary Judgment of Non-Infringement

This Court should reverse the district court's summary judgment that erroneously found the accused Wii system does not infringe claims 1, 3, 5, 6, and 12 of the '729 patent. Specifically, the district court's summary judgment should be reversed because it rests on erroneous constructions of the "handheld device" and "image sensor" limitations. A36-38; ***see*** Part V.B.1, 2 above (discussing

erroneous constructions). In addition, even if this Court affirms the district court's first construction of "handheld device" (as a "handheld direct pointing device"), this Court should still reverse summary judgment because there was at least a genuine dispute as to whether the Wii Remote is such a "handheld direct pointing device."

1. The Wii Remote Is a "Handheld Device" Under an Ordinary Meaning, as Claimed

Claims 1, 3, 5, 6, and 12 recite only a "handheld device." A317 (33:64) to A317 (34:3), A317 (34:31-33), A318 (36:1-2). In the summary judgment briefing, none of the parties disputed that the Wii Remote is a "handheld device" under the ordinary meaning of this term. A13405, A13419 (Nintendo acknowledging that "[t]he Wii Remote is held in the user's hand and used to control the system."); A1492, A14970 (Fig. 2); A14835-36; A16609-10 (partially reproduced in Fig. 2 at page 4 above).

2. The Wii Remote Is a "Handheld Direct Pointing Device," as First Construed

Even under the Texas district court's first construction of "handheld device" as requiring a "handheld <u>direct pointing</u> device," there was overwhelming evidence that the Wii Remote satisfies this construction. But at a minimum, there was at least a genuine dispute sufficient to preclude summary judgment. In its summary

judgment ruling, the Washington district court summarized some of this overwhelming evidence:

> [T]he Wii Operations Manual instructs the user to "[p]oint the remote at a specific place on the TV screen" in order to move or control the objects imaged thereon. In addition, Nintendo has in the past referred to or described the remote as a direct pointing device. Nintendo internally calls the operative part of the Wii remote a "DPD," short for "direct pointing device." In prior litigation involving an invention that claimed an indirect pointing system, Nintendo's then-expert opined that the "Wii uses an absolute pointing technique to control a cursor on the screen. Users point the Wii Remote directly at the screen, as if using a laser pointer."

A36 (emphasis added). Thus, the Washington district court found that if the accused Wii system was set up according to Nintendo's instruction manual, and the handheld Wii Remote were aimed at the screen, the system would place the cursor by approximating the intersection of the physical point-of-aim with the screen, "giving the user the impression of direct pointing." A37 (emphasis added).

In more specific detail, UltimatePointer submitted the following summary judgment evidence demonstrating that the Wii Remote is a handheld "direct pointing" device:

(1) Nintendo's two manuals for the Wii system. A16609-10 ("Point the remote at a specific place on the TV screen"); A16612-27 (instructing, e.g., "[t]o select any of these activities, simply point at one with the Wii Remote"); ***see also*** Figs. 2 and 7 at pages 4 and 18 above.

(2) Nintendo's Wii technical documents. ***E.g.***, A14886 (noting that the [redacted]); A14942 [redacted]).

(3) An analysis of the Wii Remote by UltimatePointer's experts. A14836-40, A14884-45 (determining that the Wii Remote is a handheld "direct pointing" device).

Fig. 9. Controlling a Cursor. A14858.

(4) An analysis of the Wii Remote by Nintendo's past technical expert. A14923-24, A14926, A14928-31 (describing in detail how "[u]sers point the Wii Remote directly at the screen, as if using a <u>laser pointer</u>" which is [redacted];[7] reproducing [redacted]) (emphasis added).

---

[7] ***Cf***. A259 (1:60-65) ('321 patent noting that "[d]irect pointing devices include the so-called "<u>laser pointer</u>" and the human pointing finger. . . . [whereas] [i]ndirect pointing devices . . . include a <u>mouse</u>") (emphasis added).

(5) A verified video exhibit of the Wii Remote being operated according to Nintendo's instructions for direct pointing. A15071 (CD-ROM).[8]

Fig. 10. Screen Captures of Direct Pointing in Wii Video.
A15071 (cursor highlighting added).

In its summary judgment order, the Washington district court dismissed this significant evidence of "direct pointing" because (1) a user might need to adjust the cursor position by "visual feedback," even if the system was set up according to Nintendo's instructions; and (2) if the system was set up in a manner <u>contrary</u> to the instructions, a user may need to point the Wii remote away from the screen to control the cursor. A37.

---

[8] In his pre-litigation discussions with Nintendo in 2005, the inventor Dr. Banning sought to establish a commercial relationship with Nintendo and referred to the Wii Remote as a "direct pointing" controller. A13361 (suggesting that his technology "may serve as an improvement on Nintendo's <u>direct-pointing</u> controller") (emphasis added); A15158 (suggesting that his invention is "closely related" to Nintendo's "<u>direct-pointing</u> controller") (emphasis added); ***see also*** A15177 (discussing "Nintendo's new <u>DirectPointing</u> Revolution [Wii] controller" with Microsoft) (emphasis added); A15183 (similar discussions with Sanyo).

Neither of these prophetic reasons justify dismissing UltimatePointer's evidence that the Wii Remote is a handheld direct pointing device. First, as described in Part V.B.1 above, the written description in the '321 patent specifically acknowledges that inaccuracies with the system and inherent human errors can both cause deviations between the physical point-of-aim and the calculated cursor location, but that these deviations would be acceptable due to "visual feedback." A270 (24:19-30), A265 (14:64) to A266 (15:10).

Similarly, it would not avoid infringement if the Wii Remote does not operate as a direct pointing device when it is set up in some fashion drastically different than according to Nintendo's instructions, e.g., moving the Sensor Bar "perpendicular to the screen or behind the user," A37. Such a configuration would squarely conflict with Nintendo's manual, which instructs users to mount the Sensor Bar centered and on top of or below the television. A14893; A16606-08. Moreover, Nintendo's prior expert observed that a [redacted] A14928 (emphasis added).

More importantly, this Court has consistently held that the "imperfect practice of an invention does not avoid infringement." ***Paper Converting Mach.***

Confidential Portions Omitted

Co. v. Magna-Graphics Corp., 745 F.2d 11, 20 (Fed. Cir. 1984). ***See also, e.g., Broadcom Corp. v. Emulex Corp.***, 732 F.3d 1325, 1338 (Fed. Cir. 2013) (noting that "[i]t is well settled that an accused device that 'sometimes, but not always, embodies a claim[] nonetheless infringes'"); ***z4 Techs., Inc. v. Microsoft Corp.***, 507 F.3d 1340, 1350 (Fed. Cir. 2007) ("[I]nfringement is not avoided merely because a non-infringing mode of operation is possible."); ***Golden Blount, Inc. v. Robert H. Peterson Co.***, 438 F.3d 1354, 1363 (Fed. Cir. 2006) (noting similarly); ***Hilgrave Corp. v. Symantec Corp.***, 265 F.3d 1336, 1343 (Fed. Cir. 2001) (noting similarly).

3. The Wii Remote Has an "Image Sensor," as Properly Construed

Under a correct construction of the "image sensor" limitation from claims 1, 3, 5, 6, and 12 of the '729 patent, there was no genuine dispute that the CMOS image sensor in the Wii Remote is, in fact, an image sensor. Here, UltimatePointer proposed construing an "image sensor" as a "sensing device able to capture an image," and Nintendo had proposed "a device that senses data from an image." A5194. Extrinsic evidence suggested that "[a]n image sensor is a device that converts an optical image into an electric signal . . . . [and] is typically" a "CCD" or "CMOS" sensor. A3493. There was no dispute that the Wii Remote has an "image sensor" under <u>any</u> of these meanings.

The Wii Remote has what Nintendo represents is a "[redacted]." A14949 (19-20), A14950 (3-8) (referring to the Wii Remote's "[redacted]"); A14928, A14931, A14932 n.3 (same); Figs. 3-5 at pages 5, 14, and 15 above. [redacted]. A14939-40 (describing pixel format and resolution); A14943-45 (describing pixel format and resolution of the [redacted]"). Thus, the summary judgment evidence demonstrated that the CMOS image sensor in the accused Wii Remote is an "image sensor" under any proper construction.

D. The District Court Erred in Granting Summary Judgment of Invalidity for Indefiniteness

This Court should reverse the district court's summary judgment that apparatus claims 1, 3, 5, and 6 of the '729 are invalid as indefinite under 35 U.S.C. § 112, ¶ 2 (2006) for including method steps. A60. The summary judgment was erroneous because the limitation at issue, i.e., "an image sensor, said image sensor generating data . . ." merely recites a structural component in terms of its functional capability — a claim format which courts have uniformly found not indefinite.

In its order granting summary judgment, the Washington district court found that the limitations reciting "'a handheld device including[] an image sensor, said image sensor generating data' . . . . set forth both an apparatus — a handheld

Confidential Portions Omitted

device including an image sensor — and <u>a use for the apparatus</u> — 'generating data.'" A59 (emphasis added). Here, the district court relied on statements by Nintendo's non-infringement expert to determine that "the phrase 'generating data' <u>arguably</u> requires the actual generation of data <u>by the image sensor</u>, not merely a capability to generate data, before infringement occurs." A60 (emphasis added) (referring to Order, A42, A48). In analyzing these statements, the district court cited ***Cross Med. Prods., Inc. v. Medtronic Sofamar Danek, Inc.***, 424 F.3d 1293, 1311-12 (Fed. Cir. 2005), to suggest that claims which recite a structure as performing a function "may not be infringed until the <u>ability</u> to perform [that function] is present." A48 (emphasis added).

1. Standards for Indefiniteness

Section 112, ¶ 2 states that "[t]he specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." The definiteness requirement focuses on "reasonable certainty." ***Nautilus, Inc. v. Biosig Instruments, Inc.***, 134 S.Ct. 2120, 2129 (2014) (emphasis added). "The definiteness requirement, so understood, mandates clarity, while recognizing that absolute precision is unattainable." ***Id***. Invalidity defenses must be proved by "clear and convincing evidence." ***Microsoft Corp. v. i4i Ltd. Partnership***, 131 S.Ct. 2238, 2242 (2011).

"A single patent may include claims directed to one or more of the classes of patentable subject matter, but no single claim may cover more than one subject matter class." ***Microprocessor Enhancement Corp. v. Texas Instruments Inc.***, 520 F.3d 1367, 1374 (Fed. Cir. 2008) ("***MEC***") (citing ***IPXL Holdings, L.L.C. v. Amazon.com, Inc.***, 430 F.3d 1377, 1384 (Fed. Cir. 2005)). The rationale underlying this restriction is based on a resulting lack of clarity as to when a claim having such mixed subject matter would be infringed. ***MEC***, 520 F.3d at 1374 (citing ***IPXL Holdings***, 430 F.3d at 1384).

In ***IPXL Holdings***, the claim at issue recited as follows:

> The **system of claim 2** [including an input means] wherein the predicted transaction information comprises both a transaction type and transaction parameters associated with that transaction type, and ***the user uses the input means*** to either change the predicted transaction information or accept the displayed transaction type[.]

430 F.3d at 1384 (emphasis and first alteration original). This claim was found indefinite because it was unclear whether infringement occurs when someone "creates a system that allows the user to change the predicted transaction information or accept the displayed transaction, or whether infringement occurs when **the user** actually uses the input means to change transaction information or . . . accept a displayed transaction." ***Id***. (emphasis added).

Similarly, in ***Rembrandt Data Technologies, LP v. AOL, L.L.C.***, an apparatus claim was found indefinite for reciting a separate method step that was

untied to any recited structure. 641 F.3d 1331, 1339-40 (Fed. Cir. 2011). The claim at issue recited as follows:

> A data transmitting device . . . comprising . . .
>
> second buffer means . . .
>
> trellis encoding means for trellis encoding the frames from said second buffer means; and
>
> <u>transmitting the trellis encoded frames</u>.

641 F.3d 1331, 1339 (Fed. Cir. 2011) (emphasis added). The last "transmitting" limitation was found to be a separate method step, thereby causing indefiniteness. ***Id***. at 1339-40.

However, this Court in ***MEC*** reached the opposite result when it reversed a summary judgment of indefiniteness. 520 F.3d at 1374, 1375. The apparatus claim at issue recited as follows:

> 7. A pipelined processor . . . comprising:
>
> a conditional execution decision logic pipeline stage . . .
>
> the conditional execution decision logic pipeline stage <u>performing</u> a boolean algebraic evaluation . . . and <u>producing</u> an enable-write with at least two states . . . [and]
>
> the conditional execution decision logic pipeline stage . . . <u>determining</u> the enable-write using the boolean algebraic evaluation[.]

520 F.3d at 1371 (emphasis added). This Court stated that "apparatus claims are not necessarily indefinite for using functional language" even when the claims do not use the means-plus-function format. ***Id***. at 1375 (citing, e.g., ***Halliburton***

Energy Servs., 514 F.3d at 1255). The Court found that claim 7 "is clearly limited to a pipelined processor possessing the recited structure and capable of performing the recited functions, and is thus not indefinite under ***IPXL Holdings***." ***MEC***, 520 F.3d at 1375 (emphasis added). In the present case, the "image sensor" limitations in claims 1 and 5 of the '729 patent likewise recite a structure capable of performing the function of "generating data," and are therefore not indefinite.

The ***Cross Medical*** case on which the Washington district court relied did not even involve the question whether an apparatus claim could be found indefinite for reciting a method step. The indefiniteness issue there was simply whether a limitation reciting "said longitudinal axis" was lacking antecedent basis. 424 F.3d at 1319. The portion of ***Cross Medical*** cited by the district court involved the issue whether the defendant Medtronic would be liable for directly infringing an apparatus claim by selling an accused device that was not yet structurally completed as required by the claims. 424 F.3d at 1309-12. The claim at issue recited a structural connection ("operatively joined"), but the accused device had no such structural connection when sold. ***Id***. at 1311. The limitations at issue in the present case do not involve structural connection limitations.

2. Apparatus Claims 1, 3, 5, and 6 of the '729 Patent Do Not Include a Method Step and Are Thus Not Indefinite

Independent claims 1 and 5 of the '729 patent are both drawn to an apparatus for controlling a feature on a computer generated image. A317 (33:62-

63), A317 (34:27-28). Claims 1 and 5 further recite a "handheld device" with an "image sensor," and a processor coupled to the handheld device which receives sensor data in order to control the feature on the image. A317 (33:64-34:38).

Claim 1 recites "an image sensor, said image sensor generating data related to the distance between a first point and a second point." A317 (33:65-67). The "first point" has a "predetermined relation to the computer generated image" and the "second point" has a "predetermined relation to a handheld enclosure." A317 (33:67) to A317 (34:3). The written description refers to a digital camera as an example of an image sensor for generating data related to distance. A310 (19:37-67).

Much like the "first point" in claim 1, claim 5 first recites "calibration points provided in a predetermined relationship to the image." A317 (34:28-29). Claim 5 then recites "an image sensor, said image sensor generating data including data of the calibration points. A317 (34:27-33). The written description refers to a "CCD" sensor or an "image capturing device, such as a digital camera" as examples of an image sensor for generating data of calibration points. A304 (7:27-30), A315 (29:31-56), A315 (30:45) to A316 (31:39).

Claims 3 and 6 of the '729 patent depend from claims 1 and 5, respectively, and further recite "at least one sensor generating data related to the orientation of said handheld device." A317 (34:14-15, 41-42). In addition to an image sensor

such as a CCD or digital camera, the ‘729 patent discloses electromagnetic tracking devices, ultrasonic tracking devices, accelerometers, and gyroscopes as examples of orientation sensors. A304 (7:19-42, 8:33-46), A310 (20:57-65), A315 (29:31-56, 30:53-64), A316 (32:63) to A317 (33:14).

The district court did not address the “at least one sensor” limitation from claims 3 and 6, either in its summary judgment order, A59-60, or in its analysis of opinions by Nintendo’s expert, A47-48. However, UltimatePointer’s analysis below, which demonstrates that claims 1 and 5 are not indefinite, applies with equal force to the similar limitation from claims 3 and 6.

Notably, the limitations at issue from claims 1, 3, 5, and 6 of the ‘729 patent do not recite “a user using” the sensor to generate data, and are thus entirely different from the limitation at issue in ***IPXL Holdings***, 641 F.3d at 1339-40. ***See also In re Katz Interactive Call Processing Patent Litig.***, 639 F.3d 1303, 1318 (Fed. Cir. 2011) (finding indefinite a claim reciting a “system . . . [with an] interface means for providing automated voice messages . . . wherein . . . <u>individual callers digitally enter data</u>”) (emphasis added). Moreover, unlike the separate method step that was untied to any structure in ***Rembrandt***, 641 F.3d at 1339-40, the limitations at issue in the present case are specifically tied to and recited as functions of the “image sensor” and the “at least one sensor” components.

Apparatus claims 1 and 5 recite "an image sensor, said image sensor generating data," and apparatus claims 3 and 6 recite "at least one sensor generating data," much like the limitations at issue in ***MEC***, 520 F.3d at 1371. These claims do not recite a method step are therefore not indefinite. They are properly limited to a sensor "possessing the recited structure and capable of performing the recited functions." ***Id***. at 1375. UltimatePointer's expert likewise analyzed the "sensor" limitations at issue and found that a person of ordinary skill would understand that these limitations recite a sensor "capable of" generating the specified data. A13343, A13352 (emphasis added); ***cf***. A14928-29 (Nintendo's retained expert in a prior case noting that the Wii Remote with its [redacted]) (emphasis added).

The recitation of a structural component with its corresponding function was similarly found not indefinite in ***HTC Corp. v. IPCom GmbH & Co., KG***, 667 F.3d 1270 (Fed. Cir. 2012). There, the claim at issue recited a "mobile station" for use in a particular "network." ***Id***. at 1274. The network included "first base station" and "second base station" components which performed "six enumerated

Confidential Portions Omitted

functions." ***Id***. at 1274, 1277 (e.g., "storing link data" and "deleting the link data"). This Court found the claim not indefinite and reversed the district court's summary judgment. ***Id***. at 1277-78, 1283 (noting that "[t]he claims merely establish those [six] functions as the underlying network environment in which the mobile station operates").

This Court also reversed a summary judgment of indefiniteness in ***Biosig Instruments, Inc. v. Nautilus, Inc.***, 715 F.3d 891, 903-05 (Fed. Cir. 2013), ***vacated on other grounds***, 134 S.Ct. 2120 (2014) . Much like ***MEC***, the Court in ***Biosig*** first noted that "this court's jurisprudence does not proscribe drafting or defining [apparatus] claims in relation to their functions." 715 F.3d at 903. The claim at issue recited "[a] heart rate monitor . . . whereby, a first . . . signal will be detected . . . and a second . . . signal . . . will be detected." ***Id.*** at 895, 899 (emphasis added). This Court in ***Biosig*** distinguished ***IPXL Holdings*** and found that the claim was clearly limited to a heart rate monitor possessing the recited structure that is capable of the recited function." 715 F.3d at 904.

Numerous district courts have also found claims not indefinite for reciting a structure and its corresponding function, including functions recited with an active verb, and functions recited with a "for" or "capable of" verb modifier.

For example, in ***CSB-System Int'l. Inc. v. SAP America, Inc.***, the district court rejected indefiniteness for claims reciting "said integration element receiving

signals . . . and sending back signals." 864 F. Supp.2d 335, 350-53 (E.D. Pa. 2012). The court distinguished these claims from those in ***Rembrandt*** because they did not contain any "independently standing method limitation that does not grammatically modify a particular apparatus." ***Id***. at 350-51.

Likewise, in ***Radware, Ltd. v. A10 Networks, Inc.***, the district court rejected indefiniteness for a claim reciting "[a] network management system . . . comprising a network controller receiving a client request." Nos. C-13-02021, C-13-02024, 2014 WL 2738538 at *4-5 (N.D. Cal. June 11, 2014) (emphasis added). The court further noted that the lack of a verb modifier, i.e., for "receiving" or capable of "receiving," did not impact its analysis. ***Id***. at *5 (emphasis added); ***see also, e.g., SFA Systems, L.L.C. v. 1-800-Flowers.com, Inc.***, 940 F. Supp.2d 433, 455 (E.D. Tex. 2013); ***Intermec Technologies Corp. v. Palm Inc.***, 738 F. Supp.2d 522, 536, 550 (D. Del. 2010) (rejecting indefiniteness for claim reciting, e.g., "each server storing a plurality of application programs") (emphasis added).

In ***Alexsam, Inc. v. Best Buy Stores L.P.***, the magistrate rejected indefiniteness for "a processing hub receiving . . . activation data . . . [and] activating an account." No. 2:10-cv-93, 2012 WL 4894325 at *2-3 (E.D. Tex. Aug. 22, 2012) (emphasis added). The district judge adopted the magistrate's report and noted that "claims are not indefinite merely because they recite active verbs to describe what a recited system component does in the claimed system."

2012 WL 4894325 at *1 (E.D. Tex. Oct. 15, 2012) (emphasis added); ***see also Ricoh Co., Ltd. v. Katun Corp.***, 486 F. Supp.2d 395, 402-03 (D. N.J. 2007) (rejecting indefiniteness of claim reciting "[a] lid <u>to selectively plug or unplug</u> a discharge mouth" and summarizing similar cases where "claims simply use <u>active</u> language to describe the capability of the apparatuses; they do not claim the activity itself") (emphasis added).

VI. CONCLUSION AND RELIEF REQUESTED

For the foregoing reasons, Plaintiff-Appellant UltimatePointer respectfully requests that this Court grant the following relief: (1) reverse the district court's construction of claims 33, 34, 37, 51, and 52 of the '321 patent, and claims 1, 3, 5, 6, and 12 of the '729 patent; (2) reverse the district court's summary judgment finding claims 1, 3, 5, and 6 of the '729 patent invalid as indefinite; and (3) reverse the district court's summary judgment finding non-infringement of claims 1, 3, 5, 6, and 12 of the '729 patent, and remand for a trial on the merits.

/ / /

Respectfully submitted,

/s/Charles J. Rogers
Charles J. Rogers
Conley Rose, P.C.
1001 McKinney Street, Suite 1800
Houston, Texas 77002-6421
Telephone: (713) 238-8049
Facsimile: (713) 238-8008
E-mail: CRogers@conleyrose.com
Principal Attorney for
Plaintiff-Appellant
UltimatePointer, L.L.C.

Of Counsel:
Gregory L. Maag
E-mail: GMaag@conleyrose.com
Thomas L. Warden
E-mail: TWarden@conleyrose.com
Michael J. Guthrie
E-mail: MGuthrie@conleyrose.com
Conley Rose, P.C.
1001 McKinney Street, Suite 1800
Houston, Texas 77002
Telephone: (713) 238-8000
Facsimile: (713) 238-8008

ADDENDUM

ADDENDUM

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

ULTIMATEPOINTER, LLC,	
Plaintiff,	
v.	**Civil Action Nos. 6:11-CV-496 and 571 (LED)**
NINTENDO CO. LTD., *ET AL.*,	**Jury Trial Demanded**
Defendants.	

PROTECTIVE ORDER REGARDING
<u>THE DISCLOSURE AND USE OF DISCOVERY MATERIALS</u>

Plaintiff UltimatePointer, LLC (“Plaintiff”) and Defendants Nintendo Co., Ltd.; Nintendo of America Inc.; GameStop Corporation; Sears, Roebuck & Co.; Kmart Corporation; Target Corporation; Wal-Mart Stores, Inc.; Sam’s West, Inc.; RadioShack Corporation; QVC, Inc.; Trans World Entertainment Corporation; BJ’s Wholesale Club, Inc.; PC Connection, Inc.; Compusa.com Inc.; Tiger Direct, Inc.; Sam’s East, Inc.; Wal-Mart Stores Texas, LLC; Best Buy Stores, L.P.; Best Buy.com, LLC; Best Buy Purchasing, LLC; and Toys “R” Us-Delaware, Inc. (“Defendant” or “Defendants”) anticipate that documents, testimony, or information containing or reflecting confidential, proprietary, trade secret, and/or commercially sensitive information are likely to be disclosed or produced during the course of discovery, initial disclosures, and supplemental disclosures in this case and request that the Court enter this Order setting forth the conditions for treating, obtaining, and using such information.

Pursuant to Rule 26(c) of the Federal Rules of Civil Procedure, the Court finds good cause for the following Agreed Protective Order Regarding the Disclosure and Use of Discovery Materials (“Order” or “Protective Order”).

1. **<u>PURPOSES AND LIMITATIONS</u>**

(a) Protected Material designated under the terms of this Protective Order shall be used by a Receiving Party solely for this case, and shall not be used directly or indirectly for any other purpose whatsoever.

(b) To the extent any one of Defendants in this litigation provides Protected Material under the terms of this Protective Order to Plaintiff, Plaintiff shall not share that material with the other Defendants in this litigation, unless specifically authorized hereunder or with the express written permission from the producing Defendant. This Order does not confer any right to any one Defendant to access the Protected Material of any other Defendant.

(c) The Parties acknowledge that this Order does not confer blanket protections on all disclosures during discovery, or in the course of making initial or supplemental disclosures under Rule 26(a). Designations under this Order shall be made with care and shall not be made absent a good faith belief that the designated material satisfies the criteria set forth below. If it comes to a Producing Party's attention that designated material does not qualify for protection at all, or does not qualify for the level of protection initially asserted, the Producing Party must promptly notify all other Parties that it is withdrawing or changing the designation.

2. **<u>DEFINITIONS</u>**

(a) "Discovery Material" means all items or information, including from any non-party, regardless of the medium or manner generated, stored, or maintained (including, among other things, testimony, transcripts, or tangible things) that are produced, disclosed, or generated in connection with discovery or Rule 26(a) disclosures in this case.

(b) “Outside Counsel” means (i) counsel who appear on the pleadings as counsel for a Party who are not employed by a party, and (ii) partners, associates, and staff of such counsel to whom it is reasonably necessary to disclose the information for this litigation.

(c) “Patents-in-suit” means U.S. Patent Nos. 7,746,321 and 8,049,729, and any other patent asserted in this action, as well as any related patents, patent applications, provisional patent applications, continuations, and/or divisionals.

(d) “Party” means any party to this case, including all of its officers, directors, employees, consultants, retained experts, and Outside Counsel and their support staffs.

(e) “Producing Party” means any Party or non-party that discloses or produces any Discovery Material in this case.

(f) “Protected Material” means any Discovery Material that is designated as “CONFIDENTIAL,” “CONFIDENTIAL - ATTORNEYS’ EYES ONLY,” or “CONFIDENTIAL - OUTSIDE ATTORNEYS’ EYES ONLY - SOURCE CODE,” as provided for in this Order. Protected Material shall not include: (i) advertising materials that have been actually published or publicly disseminated; and (ii) materials that show on their face they have been disseminated to the public or to any government entity without a request for confidential treatment.

(g) “Receiving Party” means any Party who receives Discovery Material from a Producing Party.

(h) “Source Code” means computer code, scripts, assembly, object code, source code listings, object code listings, and Hardware Description Language (HDL) or Register Transfer Level (RTL) files that describe the hardware design of any ASIC or other chip.

3. **COMPUTATION OF TIME**

The computation of any period of time prescribed or allowed by this Order shall be governed by the provisions for computing time set forth in Federal Rules of Civil Procedure 6 and the Local Rules of the Eastern District of Texas.

4. **SCOPE**

(a) The protections conferred by this Order cover not only Discovery Material governed by this Order as addressed herein, but also any information copied or extracted therefrom, as well as all copies, excerpts, summaries, or compilations thereof, plus testimony, conversations, or presentations by Parties or their counsel in court or in other settings that might reveal Protected Material.

(b) Nothing in this Protective Order shall prevent or restrict a Producing Party's own disclosure or use of its own Protected Material for any purpose, and nothing in this Order shall preclude any Producing Party from showing its Protected Material to an individual who either prepared the Protected Material or who previously received the Protected Material through no violation of this Order or other obligation of confidentiality.

(c) Nothing in this Order shall be construed to prejudice any Party's right to use any Protected Material in court or in any court filing, either as provided hereunder, with the consent of the Producing Party, or by order of the Court.

(d) This Order is without prejudice to the right of any Party to seek further or additional protection of any Discovery Material or to modify this Order in any way, including, without limitation, an order that certain matter not be produced at all.

5. **DURATION**

Even after the termination of this case, the confidentiality obligations imposed by this Order shall remain in effect until a Producing Party agrees otherwise in writing or a court order otherwise directs.

6. **USE OF PROTECTED MATERIAL**

(a) Basic Principles. All Protected Material shall be used solely for this case or any related appellate proceeding, and not for any other purpose whatsoever, including without limitation any other litigation, patent prosecution or acquisition, patent reexamination or reissue proceedings, other post-grant review proceedings, or any business or competitive purpose or function. Protected Material shall not be distributed, disclosed or made available to anyone except as expressly provided in this Order.

(b) Limited Prosecution Bar, Re-examination and Post-Grant Review. These prohibitions are not intended to and shall not preclude Outside Counsel or other counsel for the parties from participating in proceedings on behalf of a Party asserting a claim for patent infringement or challenging the validity of any patent. However, the Parties' Outside Counsel of Conley Rose, P.C., Capshaw Derieux, LLP, SNR Denton US LLP, McGuire Woods LLP, Buether, Joe & Carpenter LLC, Yarbrough Wilcox, PLLC, and Siebman Burg Phillips & Smith, LLP ("Identified Counsel") shall not participate directly or indirectly in any reexamination, reissue, or post-grant review proceedings relating to the patents-in-suit and/or to any other patent or patent application naming Erik Banning an inventor. Furthermore, no attorney from Identified Counsel who has accessed CONFIDENTIAL -- ATTORNEYS' EYES ONLY or CONFIDENTIAL -- ATTORNEYS' EYES ONLY SOURCE CODE materials of the opposing Party or Parties may participate in patent prosecution relating to remote pointing devices for the

Case: 15-1297 Document: 23 Page: 85 Filed: 03/30/2015

later of two (2) years after the receipt of such materials or two (2) years after final resolution of this action, including any appeals. This prohibition is on an attorney-by-attorney basis and the parties agree that knowledge of these materials shall not be imputed to attorneys who did not actually access such materials.

(c) Secure Storage. Protected Material must be stored and maintained by a Receiving Party at a location and in a secure manner that ensures that access is limited to the persons authorized under this Order.

(d) Legal Advice Based on Protected Material. Nothing in this Protective Order shall be construed to prevent counsel from advising their clients with respect to this case based in whole or in part upon Protected Materials, provided counsel does not disclose the Protected Material itself except as otherwise provided in this Order.

(e) Limitations. Nothing in this Order shall restrict in any way a Producing Party's use or disclosure of its own Protected Material. Nothing in this Order shall restrict in any way the use or disclosure of Discovery Material by a Receiving Party: (i) that is or has become publicly known through no fault of the Receiving Party; (ii) that is lawfully acquired by or known to the Receiving Party independent of the Producing Party; (iii) previously produced, disclosed and/or provided by the Producing Party to the Receiving Party or a non-party without an obligation of confidentiality and not by inadvertence or mistake; (iv) with the consent of the Producing Party; or (v) pursuant to order of the Court.

(f) Cross-Production of Defendant Confidential Material. No Defendant is required to produce its Protected Material to any other Defendant or Defendants, but nothing in this Order shall preclude such production. Notwithstanding the provisions of this Protective Order, Plaintiff shall not disclose one Defendant's Protected Material to any other Defendant or

Defendants through Court filings, oral argument in Court, expert reports, deposition, discovery requests, discovery responses, or any other means, without the express prior written consent of the Defendant that produced the Protected Material. Notwithstanding the above, to the extent Plaintiff files a document under seal with the Court containing Protected Material of one or more Defendants, the filing and service of such document shall not be considered disclosure to a Defendant pursuant to this Paragraph 6(f) so long as Plaintiff serves such document only on Nintendo's Outside Counsel and indicates that such document contains "Confidential - Containing Defendant(s)' Protected Material." In such circumstances, service upon Nintendo's Outside Counsel shall be deemed sufficient to serve all Defendants. Nintendo's outside counsel is thereafter responsible for providing such filings to the remaining Defendants in whatever redacted form is appropriate to Defendants. For Plaintiff's filings that contain its own Protected Material, Plaintiff shall designate them as "Confidential -- Containing Plaintiff's Protected Material."

7. **DESIGNATING PROTECTED MATERIAL**

(a) Available Designations. Any Producing Party may designate Discovery Material with any of the following designations, provided that it meets the requirements for such designations as provided for herein: "CONFIDENTIAL," "CONFIDENTIAL - ATTORNEYS' EYES ONLY," or "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY - SOURCE CODE."

(b) Written Discovery and Documents and Tangible Things. Written discovery, documents (which include "electronically stored information," as that phrase is used in Federal Rule of Procedure 34), and tangible things that meet the requirements for the confidentiality designations listed in Paragraph 7(a) may be so designated by placing the

appropriate designation on every page of the written material prior to production. For digital files being produced, the Producing Party shall, when feasible, mark each viewable page or image with the appropriate designation, and mark the medium, container, and/or communication in which the digital files were contained. In the event that original documents are produced for inspection, the original documents shall be presumed "CONFIDENTIAL – ATTORNEYS' EYES ONLY" during the inspection and re-designated, as appropriate during the copying process.

(c) Depositions and Testimony. Parties or testifying persons or entities may designate depositions and other testimony with the appropriate designation by indicating on the record at the time the testimony is given or by sending written notice of how portions of the transcript of the testimony is designated within fourteen (14) days of receipt of the transcript of the testimony. If no indication on the record is made, all information disclosed during a deposition shall be deemed "CONFIDENTIAL – ATTORNEYS' EYES ONLY" until the time within which it may be appropriately designated as provided for herein has passed. Any Protected Material that is used in the taking of a deposition shall remain subject to the provisions of this Protective Order, along with the transcript pages of the deposition testimony dealing with such Protected Material. In such cases the court reporter shall be informed of this Protective Order and shall be required to operate in a manner consistent with this Protective Order. In the event the deposition is videotaped, the original and all copies of the videotape shall be marked by the video technician to indicate that the contents of the videotape are subject to this Protective Order, substantially along the lines of "This videotape contains confidential testimony used in this case and is not to be viewed or the contents thereof to be displayed or revealed except pursuant to the terms of the operative Protective Order in this matter or pursuant to written

Case: 15-1297 Document: 23 Page: 88 Filed: 03/30/2015

stipulation of the parties." Counsel for any Producing Party shall have the right to exclude from oral depositions, other than the deponent, deponent's counsel, the reporter and videographer (if any), any person who is not authorized by this Protective Order to receive or access Protected Material based on the designation of such Protected Material. Such right of exclusion shall be applicable only during periods of examination or testimony regarding such Protected Material.

8. **<u>DISCOVERY MATERIAL DESIGNATED AS "CONFIDENTIAL"</u>**

(a) A Producing Party may designate Discovery Material as "CONFIDENTIAL" if it contains or reflects confidential, proprietary, and/or commercially sensitive information.

(b) Unless otherwise ordered by the Court, and subject to the restrictions of Paragraphs 6 and 11, Discovery Material designated as "CONFIDENTIAL" may be disclosed only to the following:

(i) The Receiving Party's Outside Counsel, such counsel's paralegals and staff, and any copying or clerical litigation support services working at the direction of such counsel, paralegals, and staff;

(ii) Not more than three (3) representatives of the Receiving Party who are officers or employees of the Receiving Party, as well as their support staff, to whom disclosure is reasonably necessary for this case, provided that: (a) each such person has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; and (b) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Paragraph 12 below;

(iii) Any outside expert or consultant retained by the Receiving Party to assist in this action, provided that disclosure is only to the extent necessary to perform such

Case: 15-1297 Document: 23 Page: 89 Filed: 03/30/2015

work; and provided that: (a) such expert or consultant has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; (b) such expert or consultant is not a current officer, director, or employee of a Party or of a competitor of a Party, nor anticipated at the time of disclosure to become an officer, director or employee of a Party or of a competitor of a Party; and (c) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Paragraph 13 below. Without the express prior written consent of the Defendant that produced the Protected Material, no expert or consultant retained by a Defendant in this matter shall have access to "CONFIDENTIAL" Discovery Material produced by another Defendant in this matter;

(iv) Court reporters, stenographers and videographers retained to record testimony taken in this action;

(v) The Court, jury, and court personnel;

(vi) Independent trial graphics, translation, electronic discovery, and/or trial consulting personnel who have first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(vii) Mock jurors who have signed an undertaking or agreement agreeing not to disclose Protected Material and to keep any information concerning Protected Material confidential;

(viii) Any mediator who is assigned to hear this matter, and his or her staff, subject to their agreement to maintain confidentiality to the same degree as required by this Protective Order; and

(ix) Any other person with the prior written consent of the Producing Party.

Case: 15-1297 Document: 23 Page: 90 Filed: 03/30/2015

9. **DISCOVERY MATERIAL DESIGNATED AS "CONFIDENTIAL – ATTORNEYS' EYES ONLY"**

(a) A Producing Party may designate Discovery Material as "CONFIDENTIAL – ATTORNEYS' EYES ONLY" if it contains or reflects information that is extremely confidential and/or sensitive in nature and the Producing Party reasonably believes that the disclosure of such Discovery Material is likely to cause economic harm or significant competitive disadvantage to the Producing Party. The Parties agree that the following information, if non-public, shall be presumed to merit the "CONFIDENTIAL – ATTORNEYS' EYES ONLY" designation: trade secrets, pricing information, financial data, sales information, sales or marketing forecasts or plans, business plans, sales or marketing strategy, product development information, engineering documents, testing documents, employee information, and other non-public information of similar competitive and business sensitivity.

(b) Unless otherwise ordered by the Court, and subject to the restrictions set forth in Paragraphs 6 and 11, Discovery Material designated as "CONFIDENTIAL – ATTORNEYS' EYES ONLY" may be disclosed only to:

(i) The Receiving Party's Outside Counsel, provided that such Outside Counsel is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), on behalf of a Party or a competitor of a Party, and such Outside Counsel's paralegals and staff, and any copying or clerical litigation support services working at the direction of such counsel, paralegals, and staff;

(ii) Not more than three (3) in-house counsel of the Receiving Party, provided that such in-house counsel is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), as well as their paralegals and staff to whom disclosure is reasonably necessary for this case, provided that: (a)

each such person has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; and (b) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Paragraph 13 below;

(iii) Any outside expert or consultant retained by the Receiving Party to assist in this action, provided that disclosure is only to the extent necessary to perform such work; and provided that: (a) such expert or consultant has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; (b) such expert or consultant is not a current officer, director, or employee of a Party or of a competitor of a Party, nor anticipated at the time of retention to become an officer, director, or employee of a Party or of a competitor of a Party; (c) such expert or consultant is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), on behalf of a Party or a competitor of a Party; and (d) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Paragraph 13 below. Without the express prior written consent of the Defendant that produced the Protected Material, no expert or consultant retained by a Defendant in this matter shall have access to "CONFIDENTIAL – ATTORNEYS' EYES ONLY" Discovery Material produced by another Defendant in this matter;

(iv) Court reporters, stenographers and videographers retained to record testimony taken in this action;

(v) The Court, jury, and court personnel;

(vi) Independent trial graphics, translation, electronic discovery, and/or trial consulting personnel who have first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(vii) Mock jurors who have signed an undertaking or agreement agreeing not to disclose Protected Material and to keep any information concerning Protected Material confidential;

(viii) Any mediator who is assigned to hear this matter, and his or her staff, subject to their agreement to maintain confidentiality to the same degree as required by this Protective Order; and

(ix) Any other person with the prior written consent of the Producing Party.

10. **<u>DISCOVERY MATERIAL DESIGNATED AS “CONFIDENTIAL – OUTSIDE ATTORNEYS’ EYES ONLY - SOURCE CODE”</u>**

(a) To the extent production of Source Code becomes necessary to the prosecution or defense of the case, a Producing Party may designate Source Code as “CONFIDENTIAL – OUTSIDE ATTORNEYS’ EYES ONLY - SOURCE CODE” if it comprises or includes confidential, proprietary, and/or trade secret Source Code.

(b) Nothing in this Order shall be construed as a representation or admission that Source Code is properly discoverable or properly withheld in this action, to obligate any Party to produce any Source Code, or to allow withholding any Source Code.

(c) Unless otherwise ordered by the Court, Source Code designated as “CONFIDENTIAL – OUTSIDE ATTORNEYS’ EYES ONLY - SOURCE CODE” shall be subject to the provisions set forth in Paragraph 12 below, and may be disclosed, subject to Paragraphs 6 above and Paragraphs 11 and 12 below, solely to:

(i) The Receiving Party’s Outside Counsel, provided that such Outside Counsel is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), on behalf of a Party or a competitor of a

Party, and such Outside Counsel's paralegals and staff, and any copying or clerical litigation support services working at the direction of such counsel, paralegals, and staff;

(ii) Any outside expert or consultant retained by the Receiving Party to assist in this action, provided that disclosure is only to the extent necessary to perform such work; and provided that: (a) such expert or consultant has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; (b) such expert or consultant is not a current officer, director, or employee of a Party or of a competitor of a Party, nor anticipated at the time of retention to become an officer, director or employee of a Party or of a competitor of a Party; (c) such expert or consultant is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), on behalf of a Party or a competitor of a Party; and (d) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Paragraph 13 below. Without the express prior written consent of the Defendant that produced the Protected Material, no expert or consultant retained by a Defendant in this matter shall have access to "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY - SOURCE CODE" Discovery Material produced by another Defendant in this matter;

(iii) Court reporters, stenographers and videographers retained to record testimony taken in this action;

(iv) The Court, jury, and court personnel;

(v) Independent translation personnel who have first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(vi) Any mediator who is assigned to hear this matter, and his or her staff, subject to their agreement to maintain confidentiality to the same degree as required by this Protective Order; and

(vii) Any other person with the prior written consent of the Producing Party.

11. **<u>ADDITIONAL RESTRICTION ON DISCLOSURE AND ACCESS</u>**

No Access For Certain Individuals and Organizations. Notwithstanding Paragraphs 8-10 above, absent written consent of the Producing Party, neither Erik Banning nor any attorney or employee of the law firm of Wong, Cabello, Lutsch, Rutherford & Brucculeri, LLP shall be provided access to Defendants' "CONFIDENTIAL," "CONFIDENTIAL - OUTSIDE ATTORNEYS' EYES ONLY," or "CONFIDENTIAL - ATTORNEYS' EYES ONLY - SOURCE CODE" materials.

12. **<u>DISCLOSURE AND REVIEW OF SOURCE CODE</u>**

(a) Any Source Code produced in this case shall be made available for inspection, in a standardized electronic format allowing it to be reasonably reviewed and searched, at the office of its Outside Counsel or any other location mutually agreed by between the Producing Party and the Receiving Party. Source Code will be made available for inspection between the hours of 8 a.m. and 6 p.m. on business days (i.e., weekdays that are not Federal holidays), although the Parties will be reasonable in accommodating reasonable requests to conduct inspections at other times.

(b) Prior to the first inspection of any requested Source Code, the Receiving Party shall provide fourteen (14) days notice of the Source Code that it wishes to inspect. The

Case: 15-1297 Document: 23 Page: 95 Filed: 06/30/2015

Receiving Party shall provide seven (7) days notice prior to any additional inspections. Nothing shall prevent multiple inspection of the same portions of Source Code.

(c) Source Code that is designated "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY - SOURCE CODE" shall be produced for inspection and review subject to the following provisions, unless otherwise agreed by the Producing Party:

(i) All Source Code shall be made available by the Producing Party to the Receiving Party's Outside Counsel and/or other persons authorized under Paragraph 10 above in a secure room on a secured computer without Internet access or network access to other computers or peripheral devices, as necessary and appropriate to prevent and protect against any unauthorized copying, transmission, removal or other transfer of any Source Code outside or away from the computer on which the Source Code is provided for inspection (the "Source Code Computer" in the "Source Code Review Room"). Up to two additional Source Code Computers may be provided at the Receiving Party's cost. The Producing Party shall install software tools that are sufficient for viewing and searching the code produced, on the platform produced, if such tools exist and are presently used in the ordinary course of the Producing Party's business. In addition, the Receiving Party's Outside Counsel other persons authorized under Paragraph 10 above may request that commercially available software tools for viewing and searching Source Code be installed on the Source Code computer, provided, however, that (a) the Receiving Party possesses an appropriate license to such software tools; and (b) such other software tools are reasonably necessary for the Receiving Party to efficiently perform its review of the Source Code consistent with all of the protections herein. The Receiving Party must provide the Producing Party with the CD or DVD containing such licensed software tool(s) at least seven (7) days in

advance of the date upon which the Receiving Party wishes to have the additional software tools available for use on the Source Code Computer.

(ii) The Receiving Party shall not copy, remove, or otherwise transfer any portion of the source code onto any recordable media or recordable device.

(iii) The Receiving Party's Outside Counsel and/or other persons authorized under Paragraph 10 above shall be entitled to take notes relating to the Source Code, but may not transcribe more than small blocks of less than one page of the Source Code into the notes, and may not take such notes electronically on the Source Code Computer itself or any other computer.

(iv) The Producing Party may visually monitor the activities of the Receiving Party's representatives during any Source Code review, but only to ensure that no unauthorized electronic records of the Source Code and no other unauthorized information concerning the Source Code is being created or transmitted in any way.

(v) No copies of all or any portion of the Source Code may leave the room in which the Source Code is inspected except as otherwise provided herein. Further, no other written or electronic record of the Source Code is permitted except as otherwise provided herein. The Producing Party shall make available a laser printer with commercially reasonable printing speeds for on-site printing during inspection of the Source Code. The Receiving Party may print limited portions of the Source Code only as necessary to prepare court filings, pleadings, or other papers (including a testifying expert's expert report), or for deposition or trial. Any printed portion that consists of more than ten (10) pages of a continuous block of Source Code shall be presumed to be excessive, and the burden shall be on the Receiving Party to demonstrate the need for such a printed copy. The Receiving Party shall not print Source Code in

order to review blocks of Source Code elsewhere, *i.e.*, as an alternative to reviewing that Source Code electronically on the Source Code Computer, as the Parties acknowledge and agree that the purpose of the protections herein would be frustrated by printing portions of code for review and analysis elsewhere, and that printing is permitted only when necessary for the purposes stated herein. Upon printing any such portions of Source Code, the party printing the code (the Receiving Party) shall provide the printed copy to the Producing Party. Within four (4) business days from the date of the source code inspection that resulted in the printing of the code, the Producing Party shall provide to the Receiving Party one (1) copy of the previously printed code. The copies shall be Bates numbered and labeled "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY - SOURCE CODE" and constitute part of the Source Code produced by the Producing Party in this action.

(vi) The Receiving Party is not entitled to print and thereby request hard-copy production of an unlimited number of pages of source code. The Receiving Party shall exercise good faith restraint in the amount of code that it requests be produced in hard-copy form. The Producing Party may in good faith object to the Receiving Party's request for a hard-copy of Source Code on the basis that the amount of Source Code requested in hard-copy form is excessive and/or not relevant to the issues in the case. Any such objection shall be made no later than five (5) business days from the date of the source code inspection. In the event of such objection, the parties shall meet and confer as soon as practicable, but in no event less than three (3) business days from the date the dispute arises. If the disputes remains after the parties have met and conferred, the Producing Party may seek a resolution of the objection by the Court on an expedited bases per the Court's rules. During the pendency of such objection, the Receiving Party shall use the objected to portions of Source Code only for the purpose of opposing the

objection, and shall make no copies of the objected to portions of Source Code. If such objection is agreed to by the parties or sustained by the Court, the Receiving Party shall promptly return the copy of objected to portions of Source Code.

(vii) All persons who will review a Producing Party's Source Code on behalf of a Receiving Party, including members of a Receiving Party's outside law firm, shall be identified in writing to the Producing Party in advance of the first time that such person reviews such Source Code in the Source Code Review Room. Such identification shall be in addition to any other disclosure required under this Order. The Producing Party may require that all persons viewing Source Code sign on each day they view Source Code a log that will include the names of persons who enter the Source Code Review Room to view the Source Code and when they enter and depart.

(viii) Unless otherwise agreed in advance by the Parties in writing, following each day on which source code inspection is done under this Order, the Receiving Party's Outside Counsel and/or other persons authorized under Paragraph 10 above shall remove all notes, documents, and all other materials from the Source Code Review Room. The Producing Party shall not be responsible for any items left in the room following each inspection session, and the Receiving Party shall have no expectation of confidentiality for any items left in the room following each inspection session without a prior written agreement to that effect.

(ix) Other than as provided above, the Receiving Party will not copy, remove, or otherwise transfer any Source Code from the Source Code Computer including, without limitation, copying, removing, or transferring the Source Code onto any recordable media or recordable device. Unless otherwise authorized under this Order, the Receiving Party will not transmit any Source Code in any way from the Producing Party's facilities or the offices

of its Outside Counsel. The Receiving Party's outside counsel of record may make no more than three (3) additional paper copies of any portions of the Source Code received from a Producing Party. Such copies shall not include copies attached to court filings or used at depositions. The Receiving Party shall maintain a log of all paper copies of the Source Code indicating the number of paper copies made and where they are stored. The Producing Party shall have the right to request access to the log upon demonstrating good cause.

(x) The Receiving Party's Outside Counsel of record and any person receiving a copy of any Source Code shall maintain and store any paper copies of the Source Code at their offices in a manner that reasonably prevents duplication of or unauthorized access to the Source Code, including, without limitation, storing the Source Code in a locked room or cabinet at all times when it is not in use.

(xi) At least seven (7) days before the date of any deposition involving Source Code, the Receiving Party shall notify the Producing Party about the portions of Source Code it wishes to use at the deposition, and the Producing Party shall bring at least two (2) printed copies of those portions to the deposition for use by the Receiving Party and the deponent. Copies of Source Code that are marked as deposition exhibits shall not be provided to the Court Reporter or attached to deposition transcripts; rather, the deposition record will identify the exhibit by its production numbers. Outside Counsel for the Parties shall be responsible for maintaining their own copies of deposition exhibits that comprise Source Code.

(xii) Except as provided in this sub-paragraph, absent express written permission from the Producing Party, the Receiving Party may not create electronic images, or make electronic copies, of the Source Code from any paper copy of Source Code for use in any manner (including by way of example only, the Receiving Party may not scan the Source Code

to a PDF or store a digital photograph the code). Images or copies of Source Code shall not be included in correspondence between the Parties (references to production numbers shall be used instead), and shall be omitted from pleadings and other papers whenever possible. Absent a written agreement by the Producing Party, all portions of Source Code which accompany any filing with the Court must be separately filed under seal in accordance with the Local Rules, and shall be referenced by Bates number in the main body of such filing. Service copies of such filing which are mailed or transmitted electronically shall not include any Source Code filed under seal.

13. **NOTICE OF DISCLOSURE**

(a) Prior to disclosing any Protected Material to any person described in Paragraphs 8(b)(ii), 8(b)(iii), 9(b)(ii), 9(b)(iii), or 10(c)(ii) (referenced below as "Person"), the Party seeking to disclose such information shall provide the Producing Party with written notice that includes: (i) the name of the Person; (ii) the present employer and title of the Person; (iii) an identification of all the Person's employers and regular consulting relationships within the last five (5) years; (iv) an identification of any business that the Person owns or controls, in whole or by majority interest; (v) an up-to-date curriculum vitae of the Person; and (vi) a list of the cases in which the Person has testified as an expert at deposition or trial within the last four (4) years. Said written notice shall also include an identification of any employer or consulting relationship related to the design, development, operation, or patenting of remote pointing devices using inertial sensors. The Party seeking to disclose Protected Material shall provide the above information so that the Producing Party may evaluate whether good cause exists to object to the anticipated disclosure. During the pendency of this action, including all appeals, the Party receiving any Protected Material shall immediately provide written notice of any change with

respect to the Person's involvement in the design, development, operation or patenting of remote pointing devices using inertial sensors.

(b) Within ten (10) days of receipt of the disclosure of the Person, the Producing Party or Parties may object in writing to the Person for good cause. In the absence of an objection at the end of the ten (10) day period, the Person shall be deemed approved under this Protective Order. There shall be no disclosure of Protected Material to the Person prior to expiration of this ten (10) day period. If the Producing Party objects to disclosure to the Person within such ten (10) day period, the Parties shall meet and confer via telephone or in person within three (3) days following the objection and attempt in good faith to resolve the dispute on an informal basis. If the dispute is not resolved, the Party objecting to the disclosure will have five (5) days from the date of the meet and confer to seek relief from the Court. If relief is not sought from the Court within that time, the objection shall be deemed withdrawn. If relief is sought, designated materials shall not be disclosed to the Person in question until the Court resolves the objection.

(c) For purposes of this section, "good cause" shall include an objectively reasonable concern that the Person will, advertently or inadvertently, use or disclose Discovery Materials in a way or ways that are inconsistent with the provisions contained in this Order.

(d) Prior to receiving any Protected Material under this Order, the Person must execute a copy of the "Agreement to Be Bound by Protective Order" (Exhibit A hereto) and serve it on all Parties.

(e) An initial failure to object to a Person under this Paragraph 13 shall not preclude the non-objecting Party from later objecting to continued access by that Person, but only for good cause that involves a change in the Person's business or professional affiliations. If

an objection is made, the Parties shall meet and confer via telephone or in person within three (3) days following the objection and attempt in good faith to resolve the dispute informally. If the dispute is not resolved, the Party objecting to the disclosure will have five (5) days from the date of the meet and confer to seek relief from the Court. The designated Person may continue to have access to information that was provided to such Person prior to the date of the objection. If a later objection is made, no further Protected Material shall be disclosed to the Person until the Court resolves the matter or the Producing Party withdraws its objection. Notwithstanding the foregoing, if the Producing Party fails to move for a protective order within five (5) business days after the meet and confer, further Protected Material may thereafter be provided to the Person.

14. **CHALLENGING DESIGNATIONS OF PROTECTED MATERIAL**

(a) A Party shall not be obligated to challenge the propriety of any designation of Discovery Material under this Order at the time the designation is made, and a failure to do so shall not preclude a subsequent challenge thereto.

(b) Any challenge to a designation of Discovery Material under this Order shall be written, shall be served on Outside Counsel for the Producing Party, shall particularly identify the documents or information that the Receiving Party contends should be differently designated, and shall state the grounds for the objection. Thereafter, further protection of such material shall be resolved in accordance with the following procedures:

(i) The Receiving Party shall have the burden of conferring either in person, in writing, or by telephone with the Producing Party claiming protection in a good faith effort to resolve the dispute. The Producing Party shall have the burden of justifying the disputed designation;

(ii) Failing agreement, and not earlier than three (3) days after such conference, the Receiving Party may bring a motion to the Court for a ruling that the Discovery Material in question is not entitled to the status and protection of the Producing Party's designation. The Parties' entry into this Order shall not preclude or prejudice either Party from arguing for or against any designation, establish any presumption that a particular designation is valid, or alter the burden of proof that would otherwise apply in a dispute over discovery or disclosure of information;

(iii) Notwithstanding any challenge to a designation, the Discovery Material in question shall continue to be treated as designated under this Order until one of the following occurs: (a) the Party who designated the Discovery Material in question withdraws such designation in writing; or (b) the Court rules that the Discovery Material in question is not entitled to the designation.

15. **SUBPOENAS OR COURT ORDERS**

If at any time Protected Material is subpoenaed by any court, arbitral, administrative, or legislative body, the Party to whom the subpoena or other request is directed shall immediately give prompt written notice thereof to every Party who has produced such Discovery Material and shall provide each such Party with an opportunity to move for a protective order regarding the production of Protected Materials implicated by the subpoena.

16. **FILING PROTECTED MATERIAL**

(a) Except as provided in Part (b) below, and absent written permission from the Producing Party or a court Order secured after appropriate notice to all interested persons, a Receiving Party may not file or disclose in the public record any Protected Material.

(b) Any Party is authorized under the local rules, including Local Rule CV-5(7), to file under seal with the Court any brief, document or materials that are designated as Protected Material under this Order. However, nothing in this section shall in any way limit or detract from this Order's requirements as to Source Code.

17. **INADVERTENT DISCLOSURE OF PRIVILEGED MATERIAL**

(a) The inadvertent production by a Party of Discovery Material subject to the attorney-client privilege, work-product protection, or any other applicable privilege or protection, despite the Producing Party's reasonable efforts to prescreen such Discovery Material prior to production, will not waive the applicable privilege and/or protection if a request for return of such inadvertently produced Discovery Material is made promptly after the Producing Party learns of its inadvertent production.

(b) Upon a request from any Producing Party who has inadvertently produced Discovery Material that it believes is privileged and/or protected, each Receiving Party shall immediately return such Protected Material or Discovery Material and all copies to the Producing Party, except for any pages containing privileged markings by the Receiving Party which shall instead be destroyed and certified as such by the Receiving Party to the Producing Party.

(c) Nothing herein shall prevent the Receiving Party from preparing a record for its own use containing the date, author, addresses, and topic of the inadvertently produced Discovery Material and such other information as is reasonably necessary to identify the Discovery Material and describe its nature to the Court in any motion to compel production of the Discovery Material.

18. **INADVERTENT FAILURE TO DESIGNATE PROPERLY**

(a) Within fourteen (14) of the entry of this Order, any Producing Party may designate any Discovery Material that was previously produced prior to the entry of this Order as Protected Material with one of the designations provided above.

(b) The inadvertent failure by a Producing Party to designate Discovery Material as Protected Material with one of the designations provided for under this Order shall not waive any such designation provided that the Producing Party notifies all Receiving Parties that such Discovery Material is protected under one of the categories of this Order within fourteen (14) days of the Producing Party learning of the inadvertent failure to designate. The Producing Party shall reproduce the Protected Material with the correct confidentiality designation within seven (7) days upon its notification to the Receiving Parties. Upon receiving the Protected Material with the correct confidentiality designation, the Receiving Parties shall return or securely destroy, at the Receiving Party's option, all Discovery Material that was not designated properly.

(c) A Receiving Party shall not be in breach of this Order for any use of such Discovery Material before the Receiving Party receives the Protected Material with the correct confidentiality designation, unless an objectively reasonable person would have realized that the Discovery Material should have been appropriately designated with a confidentiality designation under this Order. Once a Receiving Party has received notification of the correct confidentiality designation for the Protected Material with the correct confidentiality designation, the Receiving Party shall treat such Discovery Material (subject to the exception in Paragraph 17(c) below) at the appropriately designated level pursuant to the terms of this Order.

(d) Notwithstanding the above, a subsequent designation of "CONFIDENTIAL," "CONFIDENTIAL – ATTORNEYS' EYES ONLY" or

"CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE" shall apply on a going forward basis and shall not disqualify anyone who reviewed "CONFIDENTIAL," "CONFIDENTIAL – ATTORNEYS' EYES ONLY" or "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE" materials while the materials were not marked "CONFIDENTIAL – ATTORNEYS' EYES ONLY" or "CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE" from engaging in the activities set forth in Paragraph 6(b).

19. **INADVERTENT DISCLOSURE NOT AUTHORIZED BY ORDER**

(a) In the event of a disclosure of any Discovery Material pursuant to this Order to any person or persons not authorized to receive such disclosure under this Protective Order, the Party responsible for having made such disclosure, and each Party with knowledge thereof, shall immediately notify counsel for the Producing Party whose Discovery Material has been disclosed and provide to such counsel all known relevant information concerning the nature and circumstances of the disclosure. The responsible disclosing Party shall also promptly take all reasonable measures to retrieve the improperly disclosed Discovery Material and to ensure that no further or greater unauthorized disclosure and/or use thereof is made.

(b) Unauthorized or inadvertent disclosure does not change the status of Discovery Material or waive the right to hold the disclosed document or information as Protected.

20. **FINAL DISPOSITION**

(a) Not later than ninety (90) days after the Final Disposition of this case, each Party shall return all Discovery Material of a Producing Party to the respective Outside Counsel of the Producing Party or destroy such Material, at the option of the Receiving Party.

For purposes of this Order, “Final Disposition” occurs after an order, mandate, or dismissal finally terminating the above-captioned action with prejudice, including all appeals.

(b) All Parties that have received any such Discovery Material shall certify in writing that all such materials have been returned to the respective Outside Counsel of the Producing Party or destroyed. Notwithstanding the provisions for return of Discovery Material, Outside Counsel may retain one set of pleadings, trial and deposition exhibits, materials consisting of the official record at trial and on appeal, correspondence, and attorney and consultant work product (but not document productions) for archival purposes, subject to continuing protections under this Protective Order.

21. **MISCELLANEOUS**

(a) Right to Further Relief. Nothing in this Order abridges the right of any person to seek its modification by the Court in the future. By stipulating to this Order, the Parties do not waive the right to argue that certain material may require additional or different confidentiality protections than those set forth herein.

(b) Termination of Matter and Retention of Jurisdiction. The Parties agree that the terms of this Protective Order shall survive and remain in effect after the Final Determination of the above-captioned matter. The Court shall retain jurisdiction after Final Determination of this matter to hear and resolve any disputes arising out of this Protective Order.

(c) Successors. This Order shall be binding upon the Parties hereto, and subject to the obligations pertaining to the respective individuals specifically referenced above, the Parties’ attorneys, and their successors, executors, personal representatives, administrators, heirs, legal representatives, assigns, subsidiaries, divisions, employees, agents, retained consultants and experts, and any persons or organizations over which they have direct control.

Case: 15-1297 Document: 23 Page: 108 Filed: 03/30/2015

(d) Right to Assert Other Objections. By stipulating to the entry of this Protective Order, no Party waives any right it otherwise would have to object to disclosing or producing any information or item. Similarly, no Party waives any right to object on any ground to use in evidence of any of the material covered by this Protective Order. This Order shall not constitute a waiver of the right of any Party to claim in this action or otherwise that any Discovery Material, or any portion thereof, is privileged or otherwise non-discoverable, or is not admissible in evidence in this action or any other proceeding.

(e) Burdens of Proof. Notwithstanding anything to the contrary above, nothing in this Protective Order shall be construed to change the burdens of proof or legal standards applicable in disputes regarding whether particular Discovery Material is confidential, which level of confidentiality is appropriate, whether disclosure should be restricted, and if so, what restrictions should apply.

(f) Modification by Court. This Order is subject to further court order based upon public policy or other considerations, and the Court may modify this Order sua sponte in the interests of justice. The United States District Court for Eastern District of Texas is responsible for the interpretation and enforcement of this Order. All disputes concerning Protected Material, however designated, produced under the protection of this Order shall be resolved by the United States District Court for the Eastern District of Texas.

(g) Discovery Rules Remain Unchanged. Nothing herein shall alter or change in any way the discovery provisions of the Federal Rules of Civil Procedure, the Local Rules for the United States District Court for Eastern District of Texas, or the Court's own orders. Identification of any individual pursuant to this Protective Order does not make that individual available for deposition or any other form of discovery outside of the restrictions and procedures

of the Federal Rules of Civil Procedure, the Local Rules for the United States District Court for Eastern District of Texas, or the Court's own orders.

So ORDERED and SIGNED this 28th day of May, 2013.

LEONARD DAVIS
UNITED STATES DISTRICT JUDGE

Case: 15-1297 Document: 23 Page: 110 Filed: 03/30/2015

EXHIBIT A

I, ______________, acknowledge and declare that I have received a copy of the Protective Order ("Order") in *UltimatePointer, LLC v. Nintendo Co., Ltd. et al.*, United States District Court, District of Eastern District of Texas, Tyler Division, Civil Action Nos. 6:11-CV-496 (LED) and 6:11-CV-571 (LED). Having read and understood the terms of the Order, I agree to be bound by the terms of the Order and consent to the jurisdiction of said Court for the purpose of any proceeding to enforce the terms of the Order.

Name of individual: ____

Present occupation/job description: ________________________________

Name of Company or Firm: _____________________________________

Address: ____

Dated:____________________

____

[Signature]

THE HONORABLE ROBERT S. LASNIK

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

ULTIMATEPOINTER, L.L.C., Plaintiff, v. NINTENDO CO., LTD., and NINTENDO OF AMERICA INC., Defendants.	No. 2:14-cv-00865-RSL ORDER GRANTING JOINT MOTION TO ADOPT AND SUPPLEMENT AGREED PROTECTIVE ORDER

Defendants Nintendo Co., Ltd., and Nintendo of America Inc., and plaintiff UltimatePointer, L.L.C. , have jointly asked the Court to adopt the Agreed Protective Order previously entered in this case under before the case was transferred to the Western District of Washington, except to the extent that the Agreed Protective Order (attached as Exhibit A to the joint motion) is inconsistent with Local CR 5(g) regarding the sealing and redacting of documents filed with the Court. Having considered the motion, the Court hereby GRANTS the joint motion.

IT IS HEREBY ORDERED that the previously entered Agreed Protective Order, attached as Exhibit A to the joint motion, shall be followed by the parties except as follows:

(1) The conference, seal, and redaction requirements of LCR 5(g) apply. The previously entered Agreed Protective Order is amended to delete any presumptive authorization

to file confidential information under seal. The parties shall follow the procedures outlined in LCR 5(g)(1)-(9) regarding any such filing.

(2) Disputes between the remaining parties concerning Protected Material produced under the Agreed Protective Order, including issues related to its interpretation and enforcement, shall be shall be resolved by the Western District of Washington.

(3) Nothing in the Agreed Protective Order shall alter or change in any way the Local Civil Rules for the Western District of Washington.

Dated this 8th day of August, 2014.

ROBERT S. LASNIK
United States District Judge

United States District Court
WESTERN DISTRICT OF WASHINGTON

ULTIMATEPOINTER, LLC,

v.

NINTENDO CO., LTD., *et al.*

JUDGMENT IN A CIVIL CASE

CASE NUMBER: C14-865RSL

__ **Jury Verdict**. This action came before the Court for a trial by jury. The issues have been tried and the jury has rendered its verdict.

_X_ **Decision by Court**. This action came to trial or hearing before the Court. The issues have been tried or heard and a decision has been rendered.

THE COURT HAS ORDERED THAT

Judgment is entered against plaintiff and in favor of defendants.

December 24, 2014

William M. McCool
Clerk

/s/Tasha MacAdam
By, Deputy Clerk

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

ULTIMATEPOINTER, LLC, Plaintiff, v. NINTENDO CO., LTD., and NINTENDO OF AMERICA, INC., Defendants.	Case No. C14-0865RSL ORDER GRANTING DEFENDANTS' MOTION FOR SUMMARY JUDGMENT OF NON-INFRINGEMENT

This matter comes before the Court on "Defendant Nintendo's Motion for Summary Judgment." Dkt. # 492. Summary judgment is appropriate if, viewing the evidence in the light most favorable to the nonmoving party, "the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(a); L.A. Printex Indus., Inc. v. Aeropostale, Inc., 676 F.3d 841, 846 (9th Cir. 2012). Having reviewed the memoranda, declarations, and exhibits submitted by the parties, having heard the arguments of counsel, and taking the evidence in the light most favorable to UltimatePointer, the Court finds as follows:

A. "Direct Pointing Device"

All of the claims asserted in this litigation recite a "pointing device" or a "handheld device." In the context of his Markman ruling, the Honorable Leonard Davis determined that both terms refer to a "direct," as opposed to an "indirect," pointing device.

> The inventors classify pointing devices into two categories, direct-pointing devices and indirect-pointing devices. '321 Patent, 1:55–57. The '321 Patent defines "direct pointing device" as a "device[] . . . for which the physical point-of-aim coincides with the item being pointed at, i.e., it lies on the line-of-sight." *Id.* at 1:57–60. The specification characterizes the invention as a whole as a direct-pointing system that improves upon both indirect-pointing devices and prior direct-pointing devices. *Id.* at 2:1–38. Subsequently, the specification refers to the system as a "direct-pointing device." '321 Patent, 24:29–30. The patent contemplates indirect pointing only when direct pointing is "not possible or not desired," for example, when the pointing device is out of range of the base station or too far from where it was calibrated. 29:66–30:28. In such cases, indirect pointing may be used "as described in the cited prior art." *Id.* at 30:26–27. Thus, although the specification mentions indirect pointing, it is clear that the invention is aimed at direct pointing. Therefore, "*pointing device*" is construed as "direct pointing device."

Dkt. # 268 at 6 (internal footnote omitted). Nintendo seeks summary judgment on the ground that plaintiff has failed to provide any evidence that the Wii remote is a "direct pointing device."

Plaintiff points out that the Wii remote is designed to give the appearance and imitate the functionality of a "direct pointing device" when used as directed: the Wii Operations Manual instructs the user to "[p]oint the remote at a specific place on the TV screen" in order to move or control the objects imaged thereon. In addition, Nintendo has in the past referred to or described the remote as a direct pointing device. Nintendo internally calls the operative part of the Wii remote a "DPD," short for "direct pointing device." In prior litigation involving an invention that claimed an indirect pointing system, Nintendo's then-expert opined that the "Wii uses an absolute pointing technique to control a cursor on the screen. Users point the Wii Remote directly at the screen, as if using a laser pointer." Decl. of Thomas L. Warden (Dkt. # 517), Ex. 9 at 4. Both parties agree that a laser pointer is a "direct pointing device."

These statements notwithstanding, the Wii remote is not, in fact, a direct pointing device as described by the patents and Judge Davis. Although the system can be set up to give the impression that the user is placing the cursor on the screen at the point of aim, in reality it is the remote's interaction with the Wii sensor bar, not the screen, that is relevant to the placement

of the cursor. If the sensor bar is place directly above or below the screen as directed in the Operations Manual, the remote will pick up the LED lights when it is aimed at the screen and approximate the intersection of the physical point-of-aim with the screen, giving the user the impression of direct pointing. But the Wii does not collect or generate the data that would be necessary to accurately place a cursor on the screen through "direct pointing," and the user is often compelled to adjust the location of the cursor using visual feedback even when the sensor bar and the screen are closely aligned. If the sensor bar is placed elsewhere, such as perpendicular to the screen or behind the user, the user must aim the remote toward the sensor bar (even if that means pointing it away from the screen) in order to have the cursor appear on the screen. The terms "pointing device" and "handheld device," as construed, contemplate a product that places the cursor on the screen at the physical point of aim. The Wii does not do that. Nintendo is therefore entitled to a summary determination of non-infringement on all of the asserted claims.

B. "Image Sensor"

Claims 1, 3, 5, 6, and 12 of the '729 patent recite a handheld device containing an "image sensor." Judge Davis construed the "image sensor" to mean "a device that measures the intensity of reflected light from an image." Dkt. # 268 at 28. UltimatePointer has taken the position that Nintendo's product satisfies this limitation because the sensor located at the end of the Wii remote senses light from the infrared LEDs on the Wii sensor bar. This argument fails for two reasons. First, the light emitted from the LEDs is not an "image" as that term is used in the '729 patent. Second, there is no evidence from which a reasonable jury could conclude that the Wii sensor "measures the intensity of reflected light." The experts agree that the light from the Wii sensor bar is a combination of light emanating directly from the LEDs and light that bounces off of (*i.e.*, is reflected by) the surrounding reflector cups. The sensor at the end of the Wii remote cannot distinguish between the direct and reflected light and does not, therefore, "measure[] the intensity of reflected light" as required by the claims of the '729 patent. Simply

measuring the intensity of all light coming from the LEDs does not satisfy the claim limitation. Thus, Nintendo is entitled to a summary determination of non-infringement on claims 1, 3, 5, 6, and 12 of the '729 patent.

C. "First Angle" and "Second Angle"

Claim 12 of the '321 patent claims a method for controlling the placement of a cursor on a computer screen image that involves "measuring a first angle between a pointing line and a first line" and "measuring a second angle between said pointing line and a second line." The "pointing line" is the "line that extends in the direction of pointing." Dkt. # 268 at 12. The "first" and "second" lines both are "related in a predetermined way to a geographic reference." '321 patent at 35:17-21.

UltimatePointer has taken the position that the "first line" is the line formed by the LED lights in the Wii sensor bar. The angle between the pointing line and this "first line" obviously depends on where the Wii user is standing (or sitting). Assuming, for purposes of this discussion, that the user is standing directly in front of the Wii sensor bar, the angle between the pointing line and the line drawn through the sensor bar LEDs will be approximately 90°. <u>See</u> Dkt. # 530 at 10, Fig. N. That is not, however, the "first angle" as far as UltimatePointer is concerned. Rather, plaintiff argues that the Wii system measures a "roll" angle reflecting the amount of twist the user gives the remote around the pointing line. That angle is measured between the line drawn through the sensor bar LEDs (the "first line") and another line drawn through the x or pitch axis of the Wii remote. <u>See</u> Dkt. # 516 at 31, Fig. 22; Dkt. # 530 at 11, Fig. P. When the remote is twisted or rolled around the pointing line, the line through the x or pitch axis swings up or down from the horizon line formed by the LED sensor lights, creating the angle that plaintiff says is measured in the Wii system. That angle, however, is not between the pointing line and the "first line" identified by UltimatePointer[1] and does not, therefore,

---

[1] Assuming the user has not wandered around the room, the angle between the pointing line and the line drawn through the sensor bar LEDs remains in the 90° range even if the user twists or rolls the

satisfy the limitation of claim 12 of the ‘321 patent.

UltimatePointer’s arguments regarding the “second line” and “second angle” fail for the same reasons. Plaintiff’s experts identify the “second line” as a vertical line in the direction of gravity. Assuming the user is holding the Wii remote in a generally horizontal position, the angle between the pointing line and that second line will again approximate 90° and will not change regardless of whether the user twists or rolls the remote around the pointing line. See Dkt. # 530 at 11, Fig. R. The angle UltimatePointer relies upon to satisfy the “second angle” limitation is formed between the vertical gravity line and another line drawn through the z or yaw axis of the Wii remote, which swings left or right from vertical as the remote is twisted or rolled. See Dkt. # 516 at 31, Fig. 22; Dkt. # 530 at 12, Fig. T. Because that angle is not between the pointing line and the “second line” identified by UltimatePointer, the “second angle” limitation is not satisfied.

D. Direct, Contributory, and Indirect Infringement

Claim 12 of the ‘321 and the ‘729 patents are method claims that can be infringed only by use. UltimatePointer does not oppose summary judgment on its direct infringement claims (recognizing that they offer no remedy beyond that which is available on its indirect infringement claims).

A person is liable for contributory infringement if he “offers to sell or sells . . . a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use.” 35 U.S.C. § 271(c). Nintendo argues that the Wii system has substantial noninfringing uses, such as playing games, browsing the internet, or watching movies, which preclude a finding of contributory infringement. UltimatePointer counters that the Wii menu function is an integral part of the accused systems that, in most instances, must be

---

Wii remote around the pointing line.

used to access the noninfringing activities identified by Nintendo, and that the existence of additional, noninfringing functions does not change the fact that Nintendo is contributing to infringement.

Faced with a similar argument in <u>Lucent Techs., Inc. v. Gateway, Inc.</u>, 580 F.3d 1301 (Fed. Cir. 2009), the Federal Circuit considered a hypothetical where a software program had five features, each of which infringed a different patent. If Nintendo's argument in this case (and Microsoft's argument in <u>Lucent Technologies</u>) were correct, the hypothetical software seller "can never be liable for contributory infringement of any one of the method patents because the entire software program is capable of substantial noninfringing use. This seems both untenable as a practical outcome and inconsistent with both the statute and governing precedent." <u>Id.</u> at 1320. Instead, the court found that where the infringing feature is suitable only for infringing use and is included in a product with other, noninfringing features, the jury could reasonably conclude that defendant intended computer users to use the feature and was therefore contributing to infringement. <u>Id.</u> at 1320-21. In <u>Lucent Technologies</u>, the infringing feature was a single tool offered in Microsoft's Outlook program: customers might or might not use the feature, but any use of the tool would infringe the patent. In this case, the infringing feature – the Wii menu function – is almost always utilized by the user. The analysis of <u>Lucent Technologies</u> applies with even more force in this case. The Court finds that a reasonable jury could conclude that Nintendo intended Wii users to use the menu function and that the only way to use that function in the accused device allegedly infringed plaintiff's method claims.

With regards to plaintiff's claim of indirect infringement, Nintendo argues that the claim was abandoned when plaintiff provided expert reports that did not discuss indirect infringement. Nintendo does not, however, show that proof of indirect infringement of a method claim requires expert testimony or that the record is devoid of evidence to support such a claim. UltimatePointer has not affirmatively withdrawn its indirect infringement claim, and Nintendo's prior declaration does not make it so. Defendant has not shown that it is entitled to summary

judgment on the indirect infringement claim.

For all of the foregoing reasons, defendant's motion for summary judgment is GRANTED. Because defendant is entitled to summary judgment of noninfringement on the remaining asserted claims, namely claim 12 of the '321 patent and claims 1, 3, 5, 6, and 12 of the '729 patent, plaintiff cannot succeed on its claims of contributory and indirect infringement.

Dated this 22nd day of December, 2014.

Robert S. Lasnik
United States District Judge

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

ULTIMATEPOINTER, LLC,

Plaintiff,

v.

NINTENDO CO., LTD., and NINTENDO OF AMERICA, INC.,

Defendants.

Case No. C14-0865RSL

ORDER GRANTING IN PART PLAINTIFF'S MOTIONS *IN LIMINE*

This matter comes before the Court on "Plaintiff's Motion *in Limine* to Exclude Certain Opinions by Defendants' Experts." Dkt. # 483. Having reviewed the memoranda, declarations, and exhibits submitted by the parties, and having heard the arguments of counsel, the Court finds as follows:

Pursuant to Fed. R. Ev. 702:

> If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

In Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579 (1993), the Supreme Court charged trial judges with the responsibility of acting as gatekeepers to prevent unreliable expert testimony

from reaching the jury. The gatekeeping function applies to all expert testimony, not just testimony based on science. Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999). To be admissible, expert testimony must be both reliable and helpful. The reliability of expert testimony is judged not on the substance of the opinions offered, but on the methods employed in developing those opinions. Daubert, 509 U.S. at 594-95. In general, the expert's opinion must be based on principles, techniques, or theories that are generally accepted in his or her profession and must reflect something more than subjective belief and/or unsupported speculation. Daubert, 509 U.S. at 590. The testimony must also be "helpful," such that a valid connection between the opinion offered and the issues of the case exists. Daubert, 509 U.S. at 591-92.

In a patent case, an expert's testimony will not be helpful if it goes to issues that will never be put before the jury. Ever since Markman v. Westview Instruments, Inc., 517 U.S. 370, 384-91 (1996), a basic precept of patent law has been that the court, not the jury, construes the scope and meaning of the claims in the patents-in-suit. The Honorable Leonard Davis, with the assistance of the parties, construed contested terms in May 2013. Those constructions (along with any constructions stipulated by the parties) will be presented to the jury, which will then determine validity and infringement based on those constructions and the plain meaning of unconstrued terms. The jury will not be asked to construe additional claim terms or to reconsider the court's constructions. With these general rules in mind, the Court considers each of plaintiff's arguments.

A. Dr. Steven Dubowsky

Dr. Dubowsky is a technical expert. UltimatePointer identifies a number of words, phrases, and clauses that Dr. Dubowsky used in his report that are not in Judge Davis' claim construction order and seeks their exclusion on the ground that the expert is attempting to alter existing claim constructions or to construe additional claims. Most of the paragraphs that contain the offending language are directed at rebutting opinions offered by plaintiff's experts.

In attempting to show that neither the claim language nor the underlying technology justifies the opposing opinions, Dr. Dubowsky explains what the invention does and how the claim language is actually manifested – or not manifested – in Nintendo's products. Although he does not necessarily parrot Judge Davis' language, the fact that there are "new" words in Dr. Dubowsky's report does not make the opinions unreliable or unhelpful. The new words must be inconsistent with Judge Davis' claim construction to warrant exclusion.

1. Simultaneous Measurements from Pointing Line

Claim 12 of the '321 patent recites:

> A method for controlling a parameter related to position of a cursor on a computer screen image, comprising:
>
> measuring a first angle between a pointing line and a first line;
>
> measuring a second angle between said pointing line and a second line, said first line being related in a predetermined way to a geographic reference, said second line being related in a predetermined way to a geographic reference, said pointing line having a predetermined relation to said pointing device, and
>
> using a first parameter related to the first angle, and a second parameter related to the second angle to control the parameter of said cursor on said computer screen image,
>
> whereby said cursor position parameter is controlled by movement of said pointing device.

Dr. Dubowsky opines that, based on his understanding of Claim 12 and the underlying math and physics concepts, the first and second angles cannot simply be the same angle measured at two different times. While the Court is unwilling to import a limitation that requires that the two angles be measured at exactly the same time, the plain language of the claim specifies and differentiates between the first and second lines, angles, and parameters. UltimatePointer and its experts cannot simply ignore the requirement for a first and second angle by measuring the same angle twice: such a construction would fail to give meaning to the claim language and, in Dr.

Dubowsky's opinion, would not enable someone to place the cursor on the screen (causing the prescribed method to fail). UltimatePointer's motion to exclude Dr. Dubowsky's testimony on this point is DENIED: to the extent plaintiff is permitted to argue that the claim can be satisfied by measuring the same angle at two different times, Dr. Dubowsky will be permitted to explain why such an interpretation of the claim language is incorrect and/or invalidating.

2. "Image Sensor"

Claims 1, 3, 5, 6, and 12 of the '729 patent recite a handheld device containing an "image sensor." Judge Davis construed the phrase to mean "a device that measures the intensity of reflected light from an image." Dkt. # 268 at 28. UltimatePointer has taken the position that Nintendo's product contains this element because its image sensor senses light from the infrared LEDs on the Wii sensor bar. Nintendo acknowledges that the LEDs contain a reflector cup that may "reflect light from an image," but argues that they also emit their own, unreflected light, and that the Wii's image sensor is unable to distinguish between the reflected light and the emitted light. Such an argument is in no way inconsistent with Judge Davis's construction of the claim. If the evidence, including the expert testimony, shows that Nintendo's image sensor cannot distinguish between the sources of light, it is hard to imagine how UltimatePointer will be able to show that the device "measures the intensity of reflected light from an image" as opposed to simply measuring the intensity of all light coming from the LEDs. UltimatePointer's motion to exclude Dr. Dubowsky's testimony on this point is DENIED.

3. "Image"

Claim 1 of the '729 patent describes an "apparatus for controlling a feature on a computer generated image" that utilizes spatial data from the handheld device "to control the feature on the image." Dr. Dubowsky adopts Judge Davis's finding that the "feature" at issue is not part of the underlying displayed image (Dkt. # 268 at 27) and argues that UltimatePointer will not be able to prove that spatial data from the handheld device is used in any way given its experts' opinions regarding the "image sensor."

UltimatePointer takes issue with the fact that Dr. Dubowsky assumes that the image on which the feature appears is the same image sensed by the "image sensor." Plaintiff offers no other viable construction of the term "image" in claim 1, however, and apparently agreed with that construction during the <u>Markman</u> hearing. Dkt. # 227-19 at ¶¶ 4-5 (plaintiff's expert declaring that the "image" for purposes of the '321 and '729 patents is "a visible representation of something or someone" on "a computer display or computer screen."). Dr. Dubowsky's assumption is in no way inconsistent with Judge Davis's claim construction. Plaintiff's motion to exclude this testimony is DENIED.

4. The "First Point" as a "Calibration Point"

UltimatePointer's experts contend that the "first point," as that term is used in claims 1 and 3 of the '729 patent, corresponds to the location of the Wii sensor bar. Dr. Dubowsky argues that such an interpretation is nonsensical from a mathematical standpoint, and that even if the sensor bar could be considered a "point," plaintiff's experts have not opined that the location of the sensor bar is used to calibrate anything, as is required by the claims. UltimatePointer points out that claims 1 and 3 "*do not even use the word* 'calibration," (Dkt. # 485 at 5 (emphasis in the original)) and suggests that Dr. Dubowsky is improperly adding a limitation to the claim. Judge Davis, however, equated "first point" with "calibration point," and defined both "as a point having a predetermined relation to the image generated by the computer." The language of claims 1 and 3 also supports Dr. Dubowsky's opinion that if the distance between the sensor bar and a second point is not used to control the feature on the image, the term "first point" is not satisfied by the Wii system. Dr. Dubowsky's testimony on this point is both helpful and reliable and will not be excluded.

5. "Calibration Point"

In response to plaintiff's experts' opinion that the infrared LEDs on the Wii sensor bar are the "first point" or the "calibration point" required by claims 5 and 6 of the '729 patent, Dr. Dubowsky reiterates that the lights would not normally be considered a "point" and that even

if that were the case, (a) data regarding the lights is not used to control the feature on the image and (b) the lights are not "in a predetermined relationship to the image" as required by the claims. These opinions are consistent with Judge Davis' claim construction and would be both helpful and reliable.

Dr. Dubowsky goes on, however, to further limit the term "calibration point" as a point "in the plane of the computer-generated image and close to the boundaries of the image" (Dkt. # 484 at 18 (¶ 104)) or as a point "used to establish 'the shape, position, size and orientation" of a television screen (Id. at ¶ 105). To the extent these limitations are supported by the specification and/or are what one of ordinary skill in the art would understand, they should have been presented to Judge Davis during the Markman hearing for consideration. They cannot be superimposed on the term "calibration point" at this point in the litigation and will not be admitted at trial.

6. "In the Box" Opinions

"[W]hoever without authorization makes, uses, offers to sell, or sells any patented invention . . . infringes the patent." 35 U.S.C. § 271(a). Dr. Dubowsky opines that Nintendo does not sell or offer for sale a product that satisfies all of the limitations of claim 12 of the '321 patent and claims 1, 3, 5, 6, and 12 of the '729 patent because the Wii is packaged for sale in a box without a screen capable of displaying the necessary "computer generated image," without an electrical source that would allow the accused product to generate, receive, or measure the specified inputs, and without the "predetermined relationship" between the various components. Dkt. # 484 at 22-23 (¶¶ 127-34).

UltimatePointer argues that Dr. Dubowsky's "in-the-box" opinions regarding claims 1, 3, 5, and 6 of the '729 patent rest on an incorrect legal premise, namely that functional limitations contained in apparatus claims must always be present in order to show infringement.[1]

---

[1] Plaintiff does not address the propriety of Dr. Dubowsky's "in-the-box" opinions regarding the two method claims asserted, claim 12 of the '321 patent and claim 12 of the '729 patent.

"[I]n every infringement analysis, the language of the claims, as well as the nature of the accused product, dictates whether an infringement has occurred." Fantasy Sports Props. v. Sportsline.com, Inc., 287 F.3d 1108, 1118 (Fed. Cir. 2002). The issue with respect to the four apparatus claims of the '729 patent is whether the claims simply describe structures that have certain capabilities or whether they require that a particular capability be presently active or enabled. Finjan, Inc. v. Secure Computing Corp., 626 F.3d 1197, 1204-05 (Fed. Cir. 2010).

In this case, the claims have multiple clauses, some of which describe structures that have certain functions but some of which arguably describe structures that have active functionality. As an example of the first type of structure, all of the claims describe an apparatus "for controlling a feature on a computer generated image." This limitation is satisfied if the accused product contains an apparatus "for controlling" the stated feature on a computer image: it does not require that the "feature" or the "computer generated image" be present at all times. As the Federal Circuit found in Finjan, reciting a structure as having a specific purpose in the "for controlling" or "for obtaining" or "for preventing" style requires only capability, not enablement. 626 F.3d at 1205. On the other hand, to the extent the identified structures are not simply described as having a specific purpose or function but rather as actually performing those functions, the claim may not be infringed until the ability to perform is present. Cross Med. Prods., Inc. v. Medtronic Sofamar Danek, Inc., 424 F.3d 1293, 1311-12 (Fed. Cir. 2005). Claim language reciting an "image sensor generating data," for example, arguably requires the actual generation of data, not merely the ability to generate data.

To the extent Dr. Dubowsky's "in-the-box" opinions require enablement when the claim language requires only capacity, they are inadmissible. The opinions stated in ¶¶ 127, 131, and 134 of his report will be excluded.

B. Dr. Gregory F. Welch

Dr. Welch has offered opinions regarding the invalidity of the '321 and '729 patents. In particular, Dr. Welch opines that eight prior art references, considered individually or in various combinations, render obvious the claims in the subject patents, that the '729 patent lacks an enabling disclosure, and that claims 1, 3, 5, and 6 of the '729 patent are indefinite.

1. Obviousness

Pursuant to 35 U.S.C. § 103(a), a patent will not issue "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art . . . ." Nintendo, the party seeking to invalidate plaintiff's patents based on obviousness, has the burden of showing by clear and convincing evidence "that a skilled artisan would have had reason to combine the teaching of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success from doing so." Procter & Gamble Co. v. Teva Pharms. USA, Inc., 566 F.3d 989, 994 (Fed. Cir. 2009). Obviousness is an issue of law decided after consideration of certain underlying facts, including (a) the scope and content of the prior art, (b) differences between the claimed invention and the prior art, (c) the level of ordinary skill in the art, and (d) secondary considerations, such as commercial success, long-felt need, and the failure of other efforts to satisfy the need. Graham v. John Deere Co., 383 U.S. 1, 17-18 (1966).

Dr. Welch opines that each of the claims in this litigation are made obvious by one or more of the eight prior art references listed in Tables 3 and 4 of his report. Dkt. # 509-1 at ¶¶ 115-16. These opinions are individually stated at ¶¶ 160-94 of his report and are supported by claim charts setting forth the scope and content of the prior art, a description of a person of ordinary skill as of the priority dates, and a discussion of secondary considerations related to obviousness. What appears to be lacking in most instances is a statement of the differences between the claimed invention and the prior art and why one of ordinary skill would have reason

to combine the prior teachings. This seems to be a function of the fact that Dr. Welch believes each asserted claim is anticipated, such that there are no missing limitations or relevant differences requiring separate discussion in the context of an obviousness analysis. See, e.g., Dkt. # 509-1 at ¶ 161 (describing any limitation missing from the Wilson reference as "insignificant"). Dr. Welch's anticipation analysis is unchallenged, and "it is commonly understood that prior art references that anticipate a claim will usually render that claim obvious . . . ." Cohesive Techs., Inc. v. Waters Corp., 543 F.3d 1351, 1364 (Fed. Cir. 2008). Thus, Dr. Welch's obviousness analysis is not unreliable simply because it rests on a showing that each limitation is actually anticipated, even if that means there are no relevant differences requiring discussion. Taken in conjunction with Dr. Welch's statements regarding the level of ordinary skill in the art and the relevant technology, it is clear that these opinions are based on an appropriate consideration of the facts relevant to the obviousness analysis. To the extent Dr. Welch's obviousness opinions are based on his anticipation analysis, they are both reliable and helpful.

Where Dr. Welch acknowledges a non-trivial or significant difference, however, he does not provide enough explanation for what would prompt one skilled in the art to supply the missing limitation. This problem is limited, however, and seems to be an issue only with regards to the Leichner reference and claim 12 of the '321 patent. Dr. Welch simply states that the lack of a "direct pointing device" limitation in Leichner does not preclude a finding of obviousness "because one skilled in the art would have readily recognized at the time of the alleged invention that Leichner could easily be modified or configured to be a direct pointing device." See, e.g., Dkt. # 509-1 at ¶ 163. Given nothing more than Dr. Welch's report, the Leichner reference, and the '321 patent, a jury would be hard-pressed to understand what would lead a skilled artisan to reconfigure the Leichner invention so that it became a direct pointing device. The vague and conclusory testimony on this topic "would not be helpful to a lay jury in avoiding the pitfalls of hindsight that belie a determination of obviousness." Innogenetics, N.F.

v. Abbott Labs., 512 F.3d 1363, 1373 (Fed. Cir. 2008). The opinion stated in ¶ 163 of Dr. Welch's report will therefore be excluded.

2. Enablement

"Enablement serves the dual function in the patent system of ensuring adequate disclosure of the claimed invention and of preventing claims broader than the disclosed invention. . . . [A] patentee chooses broad claim language at the peril of losing any claim that cannot be enabled across its full scope of coverage." MagSil Corp. v. Hitachi Global Storage Techs., Inc., 687 F.3d 1377, 1380-81 (Fed. Cir. 2012). The enablement requirement is satisfied when, at the time the application is filed, one skilled in the art could read the specification and practice the invention without "undue experimentation." In re Wands, 858 F.2d 731, 736-37 (Fed. Cir. 1988). Nintendo, as the party seeking to invalidate plaintiff's patents, has the burden of showing by clear and convincing evidence that the claimed invention could not have been practiced at the time of filing without an amount of experimentation that went beyond routine trial and error and was instead "undue." Cephalon, Inc. v. Watson Pharms., Inc., 707 F.3d 1330, 1336 (Fed. Cir. 2013).[2]

UltimatePointer objects to Dr. Welch's enablement analysis because it is based on a claim construction other than that provided by the Court. Plaintiff does not, however, identify a term or phrase that is used in a manner that is inconsistent with Judge Davis' constructions. More importantly, Dr. Welch's opinions are offered in response to plaintiff's infringement contentions. The purpose of the testimony is to show that, if UltimatePointer's understanding of the scope of its invention is correct (*e.g.*, that a "predetermined relationship" exists even if the only thing we know about the "calibration points" is that they are above or below the image), the patent does not teach how such minimal information could be used to control a feature on the image, as required by the rest of the claim. To be clear, Dr. Welch does not believe that simply

---

[2] UltimatePointer has abandoned its argument that Dr. Welch was required to analyze each of the factors listed in the enablement case law.

knowing that the calibration points are above or below the image satisfies the "predetermined relationship" limitation: he is attempting to show that such a broad interpretation gives rise to other problems, such as a failure to enable. In that context, these opinions are both reliable and helpful.

3. Indefiniteness

A claim will be invalid for indefiniteness if it is "not amendable to construction" or is "insolubly ambiguous." Star Scientific, Inc. v. R.J. Reynolds Tobacco Co., 655 F.3d 1364, 1373 (Fed. Cir. 2011). Dr. Welch opines that claims 1, 3, 5, and 6 of the '729 patent are mixed method-apparatus claims and are therefore so confusing that it is unclear whether they would be satisfied by an apparatus that simply has the capability of performing the method steps or whether the apparatus has to actually perform the steps. Dkt. # 509-1 at ¶ 210. To the extent Dr. Welch is attempting to establish, as a factual matter, that one skilled in the art would find the claims insolubly ambiguous, he offers nothing more than conclusory statements with virtually no discussion of the claim language or how one of ordinary skill would understand it. Indefiniteness is a legal issue. If claims 1, 3, 5, and 6 of the '729 patent cover both an apparatus and a method of use of that apparatus, they are indefinite under governing Federal Circuit case law. See Rembrandt Data Techs., LP v. AOL, LLC, 641 F.3d 1331, 1339-40 (Fed. Cir. 2011); IPXL Holdings, LLC v. Amazon.com, Inc., 430 F.3d 1377, 1383-84 (Fed. Cir. 2005). Dr. Welch's conclusory statements regarding the nature of the claims are unhelpful and will be excluded.

C. Thomas W. Britven

Mr. Britven is Nintendo's damages expert. UltimatePointer seeks to exclude his testimony to the extent his damage model relies on a methodology not consistent with Federal Circuit case law and/or evidence regarding settlement agreements Nintendo has entered in the past.

1. "Smallest Salable Patent-Practicing Unit"

Plaintiff takes issue with the fact that Mr. Britven did not perform a complete analysis to identify the "smallest salable patent-practicing unit" ("SSPPU") and argues that his damage calculation should be excluded because it is based on something other than the SSPPU. Plaintiff puts too much emphasis on the SSPPU in the context of Mr. Britven's rebuttal opinion.

If UltimatePointer is able to establish that Nintendo infringed its patents, it will be entitled to "damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer." 35 U.S.C. § 284. Damages are only recoverable if they are attributable to the infringing use of the claimed invention. Thus, when the invention makes up a single component of a larger product, as is the case here, the patentee:

> must in every case give evidence tending to separate or apportion the defendant's profits and the patentee's damages between the patented feature and the unpatented features, and such evidence must be reliable and tangible, and not conjectural or speculative; or he must show, be equally reliable and satisfactory evidence, that the profits and damages are to be calculated on the whole machine, for the reasons that the entire value of the whole machine, as a marketable article, is properly and legally attributable to the patented feature.

Garretson v. Clark, 111 U.S. 120, 121 (1884). Under Federal Circuit law, one way a patentee can tie damages to the claimed invention (rather than to the entire market value of the accused product) is to identify the smallest salable unit containing the patented invention and seek a royalty based on that unit. But the SSPPU analysis "is simply a step toward meeting the requirement of apportionment." Virnetx, Inc. v. Cisco Sys., Inc., 767 F.3d 1308, 1327 (Fed. Cir. 2014). If the SSPPU itself is a multi-component product containing several non-infringing features that are unrelated to the invention, simply identifying the SSPPU does not necessarily solve "the fundamental concern" that the damage calculation will be skewed. Id. In such instances, more must be done "to estimate what portion of the value of [the SSPPU] is attributable to the patented technology." Id.

Case: 15-1297 Document: 23 Page: 133 Filed: 03/30/2015

Plaintiff's expert has opined that the SSPPU is the Wii console, sensor bar, and handheld controller and has calculated a reasonable royalty based on those components. Mr. Britven, in rebuttal, argues that those components include a wide array of non-patented features that independently contribute to the operation and value of the Wii, and that using the identified SSPPU to assign value to the patented features grossly overstates plaintiff's damages. Dkt. # 503 at 58. Such testimony is reliable and will be helpful to the jury as it attempts to apportion damages between unpatented and patented features of the Wii system.

Mr. Britven also offers the opinion that the retail price of the Wii system is a reflection not just of the technology in the box, but also of certain commercial, non-technical attributes Nintendo possesses. Dkt. # 503 at 59-60. Plaintiff argues that such considerations are improper in an SSPPU analysis (Dkt. # 513 at 8), but Mr. Britven's opinion goes more toward the hypothetical negotiation than a straight apportionment between patented and unpatented features. The jury will have to determine what royalty the parties would have agreed upon had they successfully negotiated a license just before infringement began. Lucent Techs., Inc. v. Gateway, Inc., 580 F.3d 1301, 1324 (Fed. Cir. 2009). In that context, Mr. Britven's opinion is helpful in understanding Nintendo's hypothetical negotiating position, namely that some portion of the retail price attributable to defendants' market share, brand recognition, reputation, retail network, etc., should be walled off from any royalty calculation as unrelated to plaintiff's technical contribution. The testimony is both reliable and helpful in that context.

2. Settlement Agreements

In his report, Mr. Britven discusses settlement agreements Nintendo entered into with other patent holders for technology embedded in the Wii. Dkt. # 503 at 43. The evidence is offered to inform the hypothetical negotiation by providing insight into the range of rates Nintendo has been willing to pay for features incorporated into the Wii and the royalties that have been accepted by other patent holders. One of the agreements involved a patent relating to three-dimensional pointing devices and is arguably similar to the technology claimed in the '321

and ‘729 patents. While the probative value of settlement agreements to prove a reasonable royalty is reduced by the fact that they were not negotiated just before infringement began and often reflect unrelated pressures associated with litigation (see LaserDynamics, Inc. v. Quanta Computer, Inc., 694 F.3d 51, 77 (Fed. Cir. 2012)), plaintiff makes no attempt to show that the facts surrounding any of the agreements upon which Mr. Britven relied make them particularly unreliable or how their consideration would be prejudicial. Having failed to show that the likelihood of unfair prejudice or confusion outweighs the probative value of the evidence, the motion to exclude is DENIED.

For all of the foregoing reasons, plaintiff’s motion *in limine* to exclude certain expert testimony (Dkt. # 483) is GRANTED in part and DENIED in part.

Dr. Dubowsky will not be permitted to add limitations to the term “calibration point” (Dkt. # 484 at 18 (¶ 104 and ¶ 105)), nor will he be permitted to offer “in-the-box” opinions when the claim language requires only capacity (Dkt. # 484 at 22-24 (¶¶ 127, 131, and 134)).

Dr. Welch will not be permitted to testify that the Leichner reference renders obvious claim 12 of the ‘321 patent (Dkt. # 509-1 at ¶ 163) or that claims 1, 3, 5, and 6 of the ‘729 patent are invalid as indefinite (Dkt. # 509-1 at ¶ 210).

The motion is DENIED in all other respects.

Dated this 22nd day of December, 2014.

Robert S. Lasnik
United States District Judge

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

ULTIMATEPOINTER, LLC, Plaintiff, v. NINTENDO CO., LTD., and NINTENDO OF AMERICA, INC., Defendants.	Case No. C14-0865RSL ORDER REGARDING PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT

This matter comes before the Court on "Plaintiff's Motion for Summary Judgment." Dkt. # 487. Summary judgment is appropriate if, viewing the evidence in the light most favorable to the nonmoving party, "the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(a); L.A. Printex Indus., Inc. v. Aeropostale, Inc., 676 F.3d 841, 846 (9th Cir. 2012). Where the party moving for summary judgment has raised an issue which, after fair and full ventilation, requires judgment in favor of the non-moving party, the district court may sua sponte enter judgment against the moving party even in the absence of a cross-motion. Albino v. Baca, 747 F.3d 1162, 1176 (9th Cir. 2014); Fed. R. Civ. P. 56(f)(1).

Having reviewed the memoranda, declarations, and exhibits submitted by the parties and having heard the arguments of counsel, the Court finds as follows:

A. Invalidity Defenses

Under 35 U.S.C. § 282, the claims of an issued patent are presumed to be valid. See PharmaStem Therapeutics, Inc. v. ViaCell, Inc., 491 F.3d 1342, 1366 (Fed. Cir. 2007) (acknowledging "the deference that is due to a qualified government agency presumed to have done its job"). The Federal Circuit therefore requires that an accused infringer prove invalidity by clear and convincing evidence. Creative Compounds, LLC v. Starmark Labs., 651 F.3d 1303, 1310 (Fed. Cir. 2011).

1. Anticipation

"A patent claim is anticipated if each and every limitation is found in a single prior art reference." OSRAM Sylvania, Inc. v. Am. Induction Techs., Inc., 701 F.3d 698, 704 (Fed. Cir. 2012). Plaintiff argues that summary judgment regarding five of the eight prior art references relied upon by Nintendo is appropriate because Nintendo's expert, Dr. Gregory F. Welch, acknowledges that the references lack at least one of the limitations claimed in the '321 and/or '729 patents. Using the Leichner reference as an example, Dr. Welch opines, based on the governing claim construction and his understanding of the prior art, that Leichner does not disclose a direct pointing device as required by claim 12 of the '321 patent or claims 1, 3, 5, 6, or 12 of the '729 patent. Dkt. # 509-1 at ¶¶ 162 and 178. Thus, left to his own devices, Dr. Welch would not say that Leichner anticipates those claims. In the context of this litigation, however, Dr. Welch's opinions are offered in response to plaintiff's infringement contentions and must take those contentions into consideration in order to be useful. With regards to Leichner, UltimatePointer's infringement contentions against the accused product suggest that it would understand Leichner as disclosing a direct pointing device. Dr. Welch posits that if that were the case, then Leichner contains the "missing" limitation and the claims asserted in this case would be anticipated.

To be clear, Dr. Welch does not believe that the Leichner reference or the accused product contain the necessary direct pointing device. But if UltimatePointer were able to

convince the factfinder that the Wii does, indeed, practice a direct pointing device as that term was construed in this litigation, then it is his opinion that the Leichner reference does too. Thus, to the extent UltimatePointer is permitted to argue that a device that estimates a point of aim based on light received from two emitters is a direct pointing device, Dr. Welch will be permitted to explain why such an application of the claim language is invalidating. The same argument applies to Dr. Welch's opinions that the Sato reference anticipates claim 12 of the '321 patent (Dkt. # 509-1 at ¶ 168), that the Clarke reference anticipates claims 1, 3, 5, 6, and 12 of the '729 patent (Dkt. # 509-1 at ¶ 182), that the Sanbe reference anticipates claims 1, 3, 5, 6, and 12 of the '729 patent (Dkt. # 509-1 at ¶ 189), and the other Leichner-related opinions.

With regards to the Ishino reference, UltimatePointer challenges the substance of Dr. Welch's opinion that the reference anticipates claim 12 of the '321 patent, arguing that the opinion is unsupported by the analysis in the report. In particular, UltimatePointer points out that Dr. Welch does not assert or explain how an invention used to "change the perspective of a background virtual reality space" of a video game, as disclosed in Ishino (Dkt. # 509-1 at ¶ 152), satisfies the claim requirement for controlling a cursor on a computer screen image. It is not clear why UltimatePointer insists that the perspective altering aspects of the Ishino reference must align with and satisfy the "controlling a cursor" function. Dr. Welch describes the Ishino system at ¶¶ 151-52 of his report, including target points on the screen and predetermined movements of the image in response to a hit. When asked at deposition to identify what portion of the Ishino reference discloses a controlling parameter related to the position of a cursor, Dr. Welch stated that "the image of the target point" described in Ishino or the possibility that there is "some sort of mark on the screen where the gun is pointed" could stand in for the cursor described in claim 12. There is, therefore, evidence in the record to support his anticipation opinion as to the Ishino reference.

2. Obviousness

For the reasons stated in the "Order Granting in Part Plaintiff's Motions in Limine," Dr. Welch may testify regarding obviousness to the extent those opinions are based on his anticipation analysis. Although he may not testify regarding his vague and conclusory opinion that claim 12 of the '321 patent is obvious in light of the Leichner reference, the exclusion of that evidence does not warrant summary judgment in plaintiff's favor. Dr. Welch opines that a number of references invalidate claim 12 of the '321 patent: that evidence remains and precludes summary judgment.

3. Indefiniteness

A claim will be invalid for indefiniteness if it is "not amendable to construction" or is "insolubly ambiguous." Star Scientific, Inc. v. R.J. Reynolds Tobacco Co., 655 F.3d 1364, 1373 (Fed. Cir. 2011). Claims 1, 3, 5, and 6 of the '729 patent are apparatus claims disclosing "a handheld device including: an image sensor, said image sensor generating data . . . ." The claims set forth both an apparatus – a handheld device including an image sensor – and a use for the apparatus – "generating data." Such claims are indefinite because it is unclear whether the claim is infringed when one creates the system described (as one would normally expect with an apparatus claim) or whether infringement occurs only when the system is put to the specified use. Manual of Patent Examination Procedure, § 2173.05(p)(II) (8th ed. rev. 2010) ("A single claim which claims both an apparatus and the method steps of using the apparatus is indefinite under 35 U.S.C. § 112, second paragraph."); Rembrandt Data Techs., LP v. AOL, LLC, 641 F.3d 1331, 1339-40 (Fed. Cir. 2011); In re Katz Interactive Call Processing Patent Litig., 639 F.3d 1303, 1318 (Fed. Cir. 2011); IPXL Holdings, LLC v. Amazon.com, Inc., 430 F.3d 1377, 1383-84 (Fed. Cir. 2005); UltimatePointer, LLC v. Nintendo Co., Ltd., 2013 WL 2325118, at *22-23 (E.D. Tex, May 28, 2013) (invalidating claims 15, 19, 20, 23, and 25 of the '321 patent because they are "not definite as to whether the claim is infringed when the pointing-device apparatus is made or sold, or when a user actually uses it to direct a pointing line.").

UltimatePointer's reliance on Microprocessor Enhancement Corp. v. Texas Instruments, Inc., 520 F.3d 1367, 1374-77 (Fed. Cir. 2008), is misplaced. One of the claims at issue in that case was a method claim, the preamble of which specified the physical structure in which the claimed method is practiced. The court found that such preambles are not unusual and do not give rise to the sort of ambiguity that would invalidate a claim for indefiniteness: infringement of the claim was clearly limited to practicing the method in the specified structure. The second claim at issue in Microprocessor Enhancement recited an apparatus with certain functional capabilities. The court easily concluded that such claims are infringed when one creates a system having the requisite capabilities. Because actual use was not specified in or required by the claim, there was no ambiguity or indefiniteness.

Neither of those situations is presented here. In the context of evaluating Dr. Dubowsky's "in-the-box" opinions, the Court has already determined that the phrase "generating data" arguably requires the actual generation of data by the image sensor, not merely a capability to generate data, before infringement occurs. UltimatePointer has therefore claimed an apparatus and its use in a single claim, giving rise to exactly the type of ambiguity that led to the invalidation of the claims in IPXL Holdings and its progeny. Because a competitor would be hard-pressed to discern whether creating the system described in the apparatus claims would constitute infringement or whether the infringement would arise when the apparatus is used to perform the specified function, claims 1, 3, 5, and 6 of the '729 patent are indefinite and invalid as a matter of law.[1]

4. Enablement

"Enablement serves the dual function in the patent system of ensuring adequate disclosure of the claimed invention and of preventing claims broader than the disclosed

[1] In its opposition memorandum, Nintendo specifically requested entry of judgment on this issue in its favor. Plaintiff, having had a full and fair opportunity to respond both in writing and at oral argument, has failed to identify any factual issue precluding summary judgment regarding indefiniteness. See Fed. R. Civ. P. 56(e)(1).

invention. . . . [A] patentee chooses broad claim language at the peril of losing any claim that cannot be enabled across its full scope of coverage." MagSil Corp. v. Hitachi Global Storage Techs., Inc., 687 F.3d 1377, 1380-81 (Fed. Cir. 2012). The enablement requirement is satisfied when, at the time the application is filed, one skilled in the art could read the specification and practice the invention without "undue experimentation." In re Wands, 858 F.2d 731, 736-37 (Fed. Cir. 1988). Nintendo, as the party seeking to invalidate plaintiff's patents, has the burden of showing by clear and convincing evidence that the claimed invention could not have been practiced at the time of filing without an amount of experimentation that went beyond routine trial and error and was instead "undue." Cephalon, Inc. v. Watson Pharms., Inc., 707 F.3d 1330, 1336 (Fed. Cir. 2013).

UltimatePointer seeks summary judgment on the grounds that (a) Nintendo has failed to present any evidence tending to establish that certain limitations of claims 5, 6, and 12 of the '729 patent are not enabled, and (b) its evidence regarding other limitations is inadmissible and/or unpersuasive.[2] Nintendo has not addressed the first argument. The Court therefore finds that there is no evidence to support Nintendo's contention that claims 5, 6, and 12 of the '729 patent are invalid because the claimed "image sensor generating data including data of the calibration points" and "generating data including data of the calibration points" are not enabled.

With regards to the second argument, the Court has already found that Dr. Welch's testimony regarding enablement is admissible. See Order Granting in Part Plaintiff's Motions in Limine at 10-11. Dr. Welch's enablement analysis is based on UltimatePointer's infringement contentions. Essentially, Dr. Welch opines that by identifying the Wii sensor bar as the "first point" and/or a "calibration point," UltimatePointer makes it impossible for one of ordinary skill in the art to figure out how to use the distance between the specified points or data regarding

---

[2] UltimatePointer has abandoned its argument that Dr. Welch was required to analyze each of the factors listed in the enablement case law.

those points to control a cursor on the screen through direct pointing. Dr. Welch also opines that the addition of orientation limitations in dependent claims 3 and 6 does not cure the enablement problems. There is, therefore, admissible evidence in support of Nintendo's contention that claims 1, 3, 5, 6, and 12 of the "729 patent are invalid for lack of enablement.

B. Equitable Defenses

Nintendo has asserted a number of equitable defenses against plaintiff's infringement claims. The Court has already determined that the accused product does not infringe any of the asserted claims. See Order Granting Defendants' Motion for Summary Judgment of Non-Infringement. Thus, there is no need to determine whether equity bars plaintiff's claims.

For all of the foregoing reasons, plaintiff's motion for summary judgment is, for the most part, DENIED. The only argument on which UltimatePointer is entitled to summary judgment relates to Nintendo's contention that claims 5, 6, and 12 of the '729 patent are invalid because the claimed "image sensor generating data including data of the calibration points" and "generating data including data of the calibration points" are not enabled. That particular invalidity argument is now foreclosed. With regards to the other invalidity defenses, Nintendo has either raised a genuine issue of material fact or has shown that, in fact, Nintendo is entitled to judgment as a matter of law. Having found that claims 1, 3, 5, and 6 of the '729 patent are indefinite, the Court hereby enters summary judgment of invalidity as to those claims. UltimatePointer's motion for judgment on the equitable defenses is DENIED as moot.

At this point in the litigation, only Nintendo's counterclaim challenging the validity of claim 12 of the '321 patent and claim 12 of the '729 patent remains. The Court assumes that Nintendo will not pursue its counterclaim, having established that the Wii does not infringe either claim. If that assumption is incorrect, Nintendo shall notify the Court by 4:00 pm

tomorrow (Tuesday, December 23, 2014) and shall provide a brief statement of how many trial days will be needed to litigate the remaining counterclaim. If no notice is filed, judgment will be entered in this matter against plaintiff and in favor of defendant.[3] In either case, the trial currently schedule for January 5, 2014, is hereby continued.

Dated this 22nd day of December, 2014.

Robert S. Lasnik
United States District Judge

[3] The judgment would be without prejudice to defendant challenging the validity of the method claims if, after appeal, this matter were to return to the district court.

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

ULTIMATEPOINTER, L.L.C.,	§	
	§	
Plaintiff,	§	
	§	**CASE NO. 6:11-CV-496-LED**
v.	§	**CASE NO. 6:11-CV-571-LED**
	§	
NINTENDO CO., LTD., *et al*.,	§	**JURY TRIAL DEMANDED**
	§	
Defendants.	§	

ORDER

This Opinion construes the term "spatial state" in United States Patent No. 7,746,321 ("'321 Patent").

BACKGROUND

UltimatePointer, L.L.C. ("UltimatePointer") asserts several claims against Defendants, including Claim 47 of the '321 Patent. The '321 Patent is directed to using a handheld direct pointing device to control placement of a cursor on an image being shown on a large screen display. '321 Patent, Abstract. Generally, the invention tracks the movement of a direct pointing device as the position and orientation of the direct pointing device change within a three-dimensional space. An interaction region having calibration points is defined on a display screen where an image is projected. *Id*. at col. 5:44–59. Thereafter, as the direct pointing device is "aimed" at various features of the displayed image, the base station determines the position and orientation of the pointing device within the coordinate space and provides information to the system to place the displayed cursor at the location within the interaction regions that coincides with the pointing device's "point-of-aim." *Id*. at col. 6:1–4.

On January 10, 2013, the parties submitted a joint claim construction chart that construed the term "spatial state" as "[t]he state of an object in space, as characterized by its position and

Case: 15-1297 Document: 23 Page: 144 Filed: 06/30/2015

orientation." Docket No. 248. Because the parties did not dispute this term, the Court's Markman Order did not address the construction of "spatial state." *See* Docket No. 268.

On July 15, 2013, Defendants filed a Motion for Summary Judgment of Non-Infringement of Claim 47 of the '321 Patent. Docket No. 281. The Court heard arguments regarding the motion on August 27, 2013 and determined that further construction of "spatial state" as used in Claim 47 and "position" as used in the agreed construction of "spatial state" may be required. *See* Docket No. 293. Therefore, the parties submitted claim construction briefs and responses and the Court heard claim construction arguments on October 17, 2013 regarding those terms.

APPLICABLE LAW

"It is a 'bedrock principle' of patent law that 'the claims of a patent define the invention to which the patentee is entitled the right to exclude.'" *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (en banc) (quoting *Innova/Pure Water Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1115 (Fed. Cir. 2004)). In claim construction, courts examine the patent's intrinsic evidence to define the patented invention's scope. *See id.*; *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 861 (Fed. Cir. 2004); *Bell Atl. Network Servs., Inc. v. Covad Commc'ns Group, Inc.*, 262 F.3d 1258, 1267 (Fed. Cir. 2001). This intrinsic evidence includes the claims themselves, the specification, and the prosecution history. *See Phillips*, 415 F.3d at 1314; *C.R. Bard, Inc.*, 388 F.3d at 861. Courts give claim terms their ordinary and accustomed meaning as understood by one of ordinary skill in the art at the time of the invention in the context of the entire patent. *Phillips*, 415 F.3d at 1312–13; *Alloc, Inc. v. Int'l Trade Comm'n*, 342 F.3d 1361, 1368 (Fed. Cir. 2003).

The claims themselves provide substantial guidance in determining the meaning of particular claim terms. *Phillips*, 415 F.3d at 1314. First, a term's context in the asserted claim

can be very instructive. *Id*. Other asserted or unasserted claims can also aid in determining the claim's meaning because claim terms are typically used consistently throughout the patent. *Id*. Differences among the claim terms can also assist in understanding a term's meaning. *Id*. For example, when a dependent claim adds a limitation to an independent claim, it is presumed that the independent claim does not include the limitation. *Id*. at 1314–15.

"[C]laims 'must be read in view of the specification, of which they are a part.'" *Id*. (quoting *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 979 (Fed. Cir. 1995) (en banc)). "[T]he specification 'is always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.'" *Id*. (quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996)); *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1325 (Fed. Cir. 2002). This is true because a patentee may define his own terms, give a claim term a different meaning than the term would otherwise possess, or disclaim or disavow the claim scope. *Phillips*, 415 F.3d at 1316. In these situations, the inventor's lexicography governs. *Id*. Also, the specification may resolve ambiguous claim terms "where the ordinary and accustomed meaning of the words used in the claims lacks sufficient clarity to permit the scope of the claim to be ascertained from the words alone." *Teleflex, Inc.*, 299 F.3d at 1325. But, "'[a]lthough the specification may aid the court in interpreting the meaning of disputed claim language, particular embodiments and examples appearing in the specification will not generally be read into the claims.'" *Comark Commc'ns, Inc. v. Harris Corp.*, 156 F.3d 1182, 1187 (Fed. Cir. 1998) (quoting *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1571 (Fed. Cir. 1988)); *see also Phillips*, 415 F.3d at 1323. The prosecution history is another tool to supply the proper context for claim construction because a patent applicant may also define a term in prosecuting the patent. *Home Diagnostics, Inc., v. Lifescan, Inc.*, 381 F.3d 1352,

1356 (Fed. Cir. 2004) ("As in the case of the specification, a patent applicant may define a term in prosecuting a patent.").

Although extrinsic evidence can be useful, it is "'less significant than the intrinsic record in determining the legally operative meaning of claim language.'" *Phillips*, 415 F.3d at 1317 (quoting *C.R. Bard, Inc.*, 388 F.3d at 862). Technical dictionaries and treatises may help a court understand the underlying technology and the manner in which one skilled in the art might use claim terms, but technical dictionaries and treatises may provide definitions that are too broad or may not be indicative of how the term is used in the patent. *Id*. at 1318. Similarly, expert testimony may aid a court in understanding the underlying technology and determining the particular meaning of a term in the pertinent field, but an expert's conclusory, unsupported assertions as to a term's definition is entirely unhelpful to a court. *Id*. Generally, extrinsic evidence is "less reliable than the patent and its prosecution history in determining how to read claim terms." *Id*.

ANALYSIS

The term "spatial state" appears in Claims 15, 16, 18, 20, 24, 27–29, 32, and 44–50 of the '321 Patent. The parties' joint claim construction construes "spatial state" as "[t]he state of an object in space, as characterized by its position and orientation." Docket No. 248. However, this construction does not expressly identify how many dimensions of position and orientation are required by the term "spatial state."

UltimatePointer argues that "spatial state" does not require complete definition of an object in three dimensions of position or orientation. It proposes that "spatial state" should be construed as "the state of an object in space as described by one or more characteristics of position and one or more characteristics of orientation" or, in the alternative, "the state of an object in space as characterized by data relating to its position and data relating to its

orientation." Docket No. 308 at 2. Defendants argue that "spatial state" requires three dimensions of position and three dimensions of orientation be defined. They effectively propose "the state of an object in space, as defined by its three-dimensional location and three-dimensional orientation, each within a coordinate system."[1] *See* Docket No. 309 at 2.

UltimatePointer contends that determining the "spatial state" of the pointing device does not require determining three dimensions of position or orientation because such information is not required to practice the embodiments described in the '321 Patent. It contends that the embodiments only require determining the position and orientation of the pointing *line*, not of the pointing *device*. Docket No. 300 at 2. Determining the equation of the pointing line, it asserts, does not also require determining the three-dimensional position and orientation of the pointing device. *Id.* at 6, 7. UltimatePointer argues that two excerpts from the '321 Patent specification expressly support its construction.

UltimatePointer first cites to specification language which states that "in the first embodiment it is only required that the 3D position and 3D orientation of [the] pointing line . . . be known, instead of having complete information on the position of [the] pointing device . . . along the pointing line." '321 Patent at col. 28:15–19. However, the pointing line is simply an extension of the pointing device and this section of the specification clearly requires that the three-dimensional position and three-dimensional orientation of the pointing line are known. *Id.* The claims require that the pointing line have a predetermined relationship to the pointing device. *E.g. id.* at col. 33:48–50. Therefore, the pointing line equation cannot be determined

[1] The Court pieces together Defendants' proposed construction by incorporating Defendants' proposed clarifications into the agreed construction. Instead of proposing one new construction of "spatial state," Defendants propose that the terms of the agreed construction should be clarified as follows: "position" as "three-dimensional location within a coordinate system," "orientation" as "three-dimensional [orientation] . . . characterized using a three-dimensional coordinate system," and "characterized by" as "defined by." *See* Docket No. 309 at 2.

without also determining the three-dimensional position and three-dimensional orientation of the pointing device.

UltimatePointer also cites to language in the specification which states that "[i]n the Invention, any system may be used that is capable of determining *at least parts* of the orientation and position in three dimensions, with respect to coordinate system x y z, of a line-segment that substantially intersects pointing device 20." '321 Patent at col. 7:29–33 (emphasis added). According to UltimatePointer, this language indicates that only parts of the pointing device's position and orientation are required to determine the pointing line. Docket No. 300 at 7. However, this excerpt simply states that the three-dimensional position and orientation of the pointing device may be determined, not only using a three-dimensional coordinate sensor by itself, but also using multiple lower-dimensional coordinate sensors in combination. *See* '321 Patent at col. 7:3–23 ("coordinate sensing devices" may "enable measurement of the 3 dimensional position and 3 dimensional orientation of [the] pointing device" and "combinations of such different types of sensors may be used to acquire redundant measurements for quality control purposes"). Therefore, the statement that "any system may be used that is capable of determining *at least parts* of the orientation and position in three dimensions" does not indicate that fewer than three dimensions of the pointing device's position and orientation are required to determine the pointing line equation. *Id.* at col. 7:29–31 (emphasis added).

The specification describes the pointing device operating in three dimensions of space. Whereas other devices used to control a feature on an image, such as a traditional computer mouse, are limited to two dimensions of space, the '321 Patent discloses a method of direct pointing in which the pointing device may move freely in three dimensions. *See id.* at col. 1:40–43 ("[I]t is desirable for the presenter to be able to move freely in front of the audience while

retaining the capability to interact with the presentation and point to specific features on the displayed images."); *id.* at col. 1:60–61 ("Direct pointing devices include the so-called 'laser pointer' and the human pointing finger."). Further, the invention characterizes the pointing device's position and orientation using three-dimensional coordinate systems. One three-dimensional coordinate system is assigned to the base station to measure the position of the pointing device and another is assigned to the pointing device to measure its orientation. *Id.* at col. 6:67–7:8.

Therefore, in light of the specification, "spatial state" is construed as "the state of an object in space, as defined by its three-dimensional position and three-dimensional orientation."

CONCLUSION

For the foregoing reasons, the Court construes the term "spatial state" in the '321 Patent in the manner set forth above.

So ORDERED and SIGNED this 28th day of October, 2013.

LEONARD DAVIS
UNITED STATES DISTRICT JUDGE

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

ULTIMATEPOINTER, L.L.C.,	§	
	§	
Plaintiff,	§	
	§	**CASE NO. 6:11-CV-496-LED**
v.	§	**CASE NO. 6:11-CV-571-LED**
	§	
NINTENDO CO., LTD. *et al*.,	§	**JURY TRIAL DEMANDED**
	§	
Defendants.	§	
	§	

MEMORANDUM OPINION AND ORDER

This Opinion construes United States Patent No. 7,746,321 ("'321 Patent") and United States Patent No. 8,049,729 ("'729 Patent"). Also before the Court is Defendants' Motion for Summary Judgment of Invalidity for Indefiniteness (Case No. 6:11cv496, Dkt. No. 243). For the reasons discussed below, the Court **GRANTS IN PART** and **DENIES IN PART** Defendants' Motion.

BACKGROUND

UltimatePointer asserts both method and systems claims from the '321 and '729 patents. The '321 patent is directed to controlling movement of a cursor on a large screen display to point to specific features of images being displayed on the screen. '321 patent, Abstract. The invention relates to devices for making presentations in front of audiences, for which interaction with the displayed information through direct pointing is desired. *Id*. at 1:20–25. Generally, the invention tracks the movement of a pointing device as the orientation of the pointing device changes. A base station, using calibration points, locates an interaction region on a display screen where an image is presented. *Id*. at 5:44–59. The base station and the pointing device interact to identify movements of the pointing device within a three-dimensional coordinate space. *Id*. at 5:59–67.

Thereafter, as the pointing device is "aimed" at various features of the displayed image, the base station detects the orientation of the pointing device within the coordinate space and provides information to the system to direct the displayed cursor to the location within the interaction regions that coincides with the pointing device's "point-of-aim." *Id*. at 6:1–4. The '729 patent is a continuation of the '321 patent, such that the specifications and drawings are identical. *See* '321 patent, '729 patent.

APPLICABLE LAW

"It is a 'bedrock principle' of patent law that 'the claims of a patent define the invention to which the patentee is entitled the right to exclude.'" *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (en banc) (quoting *Innova/Pure Water Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1115 (Fed. Cir. 2004)). In claim construction, courts examine the patent's intrinsic evidence to define the patented invention's scope. *See id.*; *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 861 (Fed. Cir. 2004); *Bell Atl. Network Servs., Inc. v. Covad Commc'ns Group, Inc.*, 262 F.3d 1258, 1267 (Fed. Cir. 2001). This intrinsic evidence includes the claims themselves, the specification, and the prosecution history. *See Phillips*, 415 F.3d at 1314; *C.R. Bard, Inc.*, 388 F.3d at 861. Courts give claim terms their ordinary and accustomed meaning as understood by one of ordinary skill in the art at the time of the invention in the context of the entire patent. *Phillips*, 415 F.3d at 1312–13; *Alloc, Inc. v. Int'l Trade Comm'n*, 342 F.3d 1361, 1368 (Fed. Cir. 2003).

The claims themselves provide substantial guidance in determining the meaning of particular claim terms. *Phillips*, 415 F.3d at 1314. First, a term's context in the asserted claim can be very instructive. *Id*. Other asserted or unasserted claims can also aid in determining the claim's meaning because claim terms are typically used consistently throughout the patent. *Id*. Differences among the claim terms can also assist in understanding a term's meaning. *Id*. For

Case: 15-1297 Document: 23 Page: 152 Filed: 03/30/2015

example, when a dependent claim adds a limitation to an independent claim, it is presumed that the independent claim does not include the limitation. *Id.* at 1314–15.

"[C]laims 'must be read in view of the specification, of which they are a part.'" *Id.* (quoting *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 979 (Fed. Cir. 1995) (en banc)). "[T]he specification 'is always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.'" *Id.* (quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996)); *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1325 (Fed. Cir. 2002). This is true because a patentee may define his own terms, give a claim term a different meaning than the term would otherwise possess, or disclaim or disavow the claim scope. *Phillips*, 415 F.3d at 1316. In these situations, the inventor's lexicography governs. *Id.* Also, the specification may resolve ambiguous claim terms "where the ordinary and accustomed meaning of the words used in the claims lacks sufficient clarity to permit the scope of the claim to be ascertained from the words alone." *Teleflex, Inc.*, 299 F.3d at 1325. But, "'[a]lthough the specification may aid the court in interpreting the meaning of disputed claim language, particular embodiments and examples appearing in the specification will not generally be read into the claims.'" *Comark Commc'ns, Inc. v. Harris Corp.*, 156 F.3d 1182, 1187 (Fed. Cir. 1998) (quoting *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1571 (Fed. Cir. 1988)); *see also Phillips*, 415 F.3d at 1323. The prosecution history is another tool to supply the proper context for claim construction because a patent applicant may also define a term in prosecuting the patent. *Home Diagnostics, Inc., v. Lifescan, Inc.*, 381 F.3d 1352, 1356 (Fed. Cir. 2004) ("As in the case of the specification, a patent applicant may define a term in prosecuting a patent.").

Although extrinsic evidence can be useful, it is "'less significant than the intrinsic record in determining the legally operative meaning of claim language.'" *Phillips*, 415 F.3d at 1317 (quoting *C.R. Bard, Inc.*, 388 F.3d at 862). Technical dictionaries and treatises may help a court understand the underlying technology and the manner in which one skilled in the art might use claim terms, but technical dictionaries and treatises may provide definitions that are too broad or may not be indicative of how the term is used in the patent. *Id*. at 1318. Similarly, expert testimony may aid a court in understanding the underlying technology and determining the particular meaning of a term in the pertinent field, but an expert's conclusory, unsupported assertions as to a term's definition is entirely unhelpful to a court. *Id*. Generally, extrinsic evidence is "less reliable than the patent and its prosecution history in determining how to read claim terms." *Id*.

ANALYSIS

"pointing device" and related terms

The term "*pointing device*" appears in Claims 15, 19, 20, 23, 25, 27, 31 and 32 of the '321 Patent. Defendants propose "a piece of equipment used for direct pointing." UltimatePointer proposes "a piece of equipment or system component that is intended for use as a pointer."

There are several additional terms related to "pointing device" that turn on the same claim-construction analysis. The first, "*handheld enclosure*," appears in Claims 15, 19, 20, 23, 25, 33, 34, 37, 44, 51, and 52 of the '321 Patent. Defendants propose construing "handheld enclosure" as "enclosure of a handheld piece of equipment used for direct pointing." UltimatePointer proposes "an enclosure intended to be held in the user's hand."

A second related term, "*handheld device*," appears in Claims 1, 3, 5, 6, and 12 of the '729 Patent. Defendants propose "a handheld piece of equipment used for direct pointing" and

Case: 16-1297 Document: 26 Page: 154 Filed: 03/30/2016

UltimatePointer proposes “a piece of equipment or system component intended to be held in the user’s hand.”

A third related term, “*user-wielded pointing device*,” appears in Claims 27, 31, and 32 of the ‘321 Patent. Defendants propose “a user-wielded piece of equipment used for direct pointing.” UltimatePointer proposes “a piece of equipment or system component for pointing, intended to be held in the user’s hand.”

Finally, “*handheld pointing device*” appears in Claim 47 of the ‘321 patent and Claim 7 of the ’729 Patent. Defendants propose “a handheld piece of equipment used for direct pointing.” UltimatePointer proposes “a piece of equipment or system component for pointing, intended to be held in the user’s hand.”

The dispute for these five terms (collectively, the “pointing device” terms) revolves around whether the claimed pointing device is necessarily a direct, not indirect, pointing device. UltimatePointer contends that the patent does not specify that the pointing devices are *direct* pointing devices. Dkt. No. 227, at 2. UltimatePointer argues that the “pointing device” terms are broad enough to include both indirect and direct pointing devices because the specification includes examples of indirect pointing, such as a desktop mouse and trackball. *Id*. UltimatePointer adds that Defendants’ proposal excludes a preferred embodiment of the ‘321 Patent, which provides for indirect pointing. *Id*. at 3. Further, UltimatePointer argues that the word “direct” in Defendants’ proposals is insufficiently precise. *Id*. at 3. Finally, UltimatePointer argues that the “handheld” limitation is a commonly understood term and cites the dictionary definition. *Id*. at 2.

Defendants contend that the pointing device is necessarily direct because the specification repeatedly states that “the invention” as a whole requires direct pointing. Dkt. No.

Case: 15-1297 Document: 26 Page: 155 Filed: 03/30/2015

238, at 5. Defendants contend that the specification only describes the use of indirect pointing when direct pointing is not possible. *Id*. at 6. Finally, Defendants contend that the terms "handheld" and "user-wielded" are readily understood and require no construction, and that Plaintiff's construction is improperly subjective due to the "intended to be held" phrase. *Id*. at 6.

The inventors classify pointing devices into two categories, direct-pointing devices and indirect-pointing devices. '321 Patent, 1:55–57. The '321 Patent defines "direct pointing device" as a "device[] . . . for which the physical point-of-aim coincides with the item being pointed at, i.e., it lies on the line-of-sight." *Id*. at 1:57–60. The specification characterizes the invention as a whole as a direct-pointing system that improves upon both indirect-pointing devices and prior direct-pointing devices. *Id*. at 2:1–38. Subsequently, the specification refers to the system as a "direct-pointing device." '321 Patent, 24:29–30. The patent contemplates indirect pointing only when direct pointing is "not possible or not desired," for example, when the pointing device is out of range of the base station or too far from where it was calibrated. 29:66–30:28. In such cases, indirect pointing may be used "as described in the cited prior art." *Id*. at 30:26–27. Thus, although the specification mentions indirect pointing, it is clear that the invention is aimed at direct pointing.[1] Therefore, "*pointing device*" is construed as "direct pointing device."

As conceded by the parties, the "handheld" and "user-wielded" limitations are easily understood and used with their plain and ordinary meaning. Therefore, there is no need to further construe those terms. Accordingly, the term "*handheld pointing device*" is construed as a "handheld direct pointing device" and the term "*user-wielded pointing device*" is construed as "user-wielded direct pointing device."

---

[1] *Computer Docking Station Corp. v. Dell, Inc*., 519 F.3d 1366, 1378–79 (Fed. Cir. 2008) (affirming lower court's construction of the preamble term "portable computer" as excluding laptop computers based on the specification's emphasis on contrasting the claimed device from laptops, even though certain embodiments showed a device coupled to a keyboard and visual display described as "options available with the system").

As to the term "handheld enclosure," the parties do not offer any argument to support their respective proposals. Both parties' proposals, however, include the word "enclosure." Thus, there is no dispute that "enclosure" needs no construction. Because the compound term "*handheld enclosure*" does not represent any special meaning beyond its component words, the term does not need to be further construed.

With regard to "handheld device," the Parties' proposed constructions are identical to "handheld pointing device." Although the claims of the '729 patent do not specifically reference a pointing line, the claim language makes clear that the "handheld device" is nonetheless a pointing device. For example, Claim 1 recites that the handheld device has an image sensor to generate data related to "the distance between the first point and the second point," which implies a direct pointing line between the first and second point. '729 patent, 33:62–34:8. Furthermore, Claims 5 and 12 recite that the handheld device has an image sensor for generating data of calibration points. *Id.* at 34:27–38, 36:1–9. Thus, the handheld device must have a direct line of sight to (i.e., be pointed at) the calibration points to generate such data. Therefore, as required by the claims and implicitly conceded by the parties, "handheld device" is necessarily for pointing. In accordance with the construction of "pointing device," the term "*handheld device*" is construed as "handheld direct pointing device."

"using a parameter"

The term "using a parameter" appears in Claims 5, 6, and 12 of the '321 Patent. The term appears in two contexts: (1) "using a parameter related to the measured angle to control the parameter of said cursor"; and (2) "using a first parameter related to the first angle, and a second parameter related to the second angle to control the parameter of said cursor." Defendants propose a construction that adds "using direct pointing" at the end of each phrase. Thus,

Case: 16-1297 Document: 26 Page: 157 Filed: 03/30/2016

Defendants' proposed construction for the first context is "using a parameter related to the measured angle to control the parameter of said cursor using direct pointing." For the second context, it is "using a first parameter related to the first angle, and a second parameter related to the second angle to control the parameter of said cursor using direct pointing." UltimatePointer argues that no construction is necessary for this term. Again, the dispute turns on whether "using a parameter" necessarily refers to direct pointing.

As discussed above, the claims are already limited to direct pointing. Therefore, adding a "direct pointing" limitation to these terms is unnecessary. No further construction of "using a parameter" is necessary.

"projected computer screen image"

The term "projected computer screen image" appears in Claims 5 and 6 of the '321 Patent. Defendants propose "a computer screen image created by using beams of light directed through space to cause the image to fall onto a surface." UltimatePointer proposes "a computer-generated image that is displayed on a display screen." The dispute centers around whether this term is limited to images displayed by projection.

UltimatePointer argues that Defendants' proposal improperly inserts limitations not present in the claim language and excludes a preferred embodiment. Dkt. No. 227, at 4–5. UltimatePointer also contends that the disclosure of projection device 40 is merely exemplary and points to CRT and LCD embodiments mentioned in the specification as examples of non-projection display means. *Id*. at 5.

Defendants argue that "projected" is used in its ordinary sense and does not merely mean "displayed." Dkt. No. 238 at 7. Defendants point to Claim 12's recitation of "computer screen

image" to indicate that "projected computer screen image" has a different meaning beyond "displayed." *Id*.

The specification does mention CRT and LCD display screens, but only in the context of referring to the laptop-computer interface provided by device 49 as a standalone component that can be incorporated into a television or a monitor. '321 Patent, 8:52–56. In such embodiments, there is no "projected" image. However, Claims 5 and 6 specifically refer to a "projected" image. 34:2, 25–26. Therefore, the patentee narrowed the scope by inserting the term "projected" into the claim language. The term "projected computer screen image" is construed as "computer screen image created by using beams of light directed through space to cause the image to fall onto a surface."

"point of aim"

The term "point of aim" appears in Claim 6 of the '321 Patent. Defendants propose construing "point of aim" as "point at which the pointing line intersects with an object." UltimatePointer proposes "a location at which a pointing device is aimed." The issue is whether the pointing line necessarily intersects with something.

Defendants argue that their proposed construction adopts the plain meaning of the term and is consistent with the specification's written description and figures. Dkt. No. 238, at 10. Defendants contend that the patentee necessarily included the place where the pointing line intersects with an object. *Id*. at 10–11.

UltimatePointer argues that Figure 18 in the specification illustrates that the term is used in its ordinary meaning of a location. Dkt. No. 227, at 6. UltimatePointer also contends that limiting the term to require a precise intersection of a particular line with a point is not supported by the claims or the specification. *Id*.

The claim language does not mention a "pointing device," thus there is no support for including such device in the construction of "point of aim," as Plaintiff proposes. '321 Patent, 34:1–26. As to whether the point of aim necessarily intersects with the image, the claim language and the specification support a construction that includes the location of such an intersection. First, the claim recites that the cursor is "controlled by position of said point-of-aim measured relative to said projected computer screen image." '321 Patent, 34:24–26. Further, the specification describes that the point of aim "lies in projection image 70." '321 Patent, 16:35. Thus, in order for the point of aim to "lie" in the image plane, there must be an intersection of the pointing line with the object (i.e., projection screen) containing the projection image. Accordingly, "point of aim" is construed as "location at which the pointing line intersects with an object."

"directed at"

This term appears in Claims 15, 19, 20, 23, 25, 44, 47, and 51 of the '321 Patent. Defendants propose "pointed so that the point-of-aim intersects with." Plaintiff proposes "pointed at." The dispute again turns on whether the term necessarily includes an intersection.

Defendants argue that the key aspect for construing "directed at" lies in the distinction between "directed at" and another claim term, "directed towards," which are presumed to be used with different meanings. Dkt. No. 238, at 11. According to Defendants, the word "at" means the pointing line necessarily intersects with an object. *Id*. at 12.

Plaintiff relies upon a dictionary definition for a plain meaning of "directed at" as being "to point." Dkt. No. 227, at 6. Plaintiff contends that nowhere does the claim language require a precise intersection of a particular line with a point. *Id*.

The claim language specifies that a sensing device is generating data indicative of a spatial state "while the pointing line is directed at a first calibration point." 38:61–62. Thus, for the data to be generated, the pointing line must intersect with the calibration point. Therefore, "directed at" is construed as "pointed so that the point-of-aim intersects with."

"substantially pass through"

The term "directing said pointing line to substantially pass through said calibration point" appears in Claim 6 of the '321 Patent. Defendants propose "directing said pointing line such that it touches said calibration point." Plaintiff proposes "directing the pointing line to pass through or close to the calibration point." The dispute revolves around whether "substantially pass through" can include the pointing line passing near the calibration point.

Defendants argue that Plaintiff's addition of "or close to" is the opposite of the plain meaning of "substantially pass through." Dkt. No. 238, at 9. Defendants further argue that the patentee did not indicate a special definition anywhere in the specification. *Id*. Finally, Defendants contend that Plaintiff's proposed construction is subjective as to how "close" the pointing line must be to the calibration point and would render the claim indefinite. *Id*. at 10.

Plaintiff argues that "substantially pass through" carries its ordinary dictionary meaning of "largely but not wholly that which is specified." Dkt. No. 227 at 7. Plaintiff also argues that the specification shows in Figure 18 that the point of aim sometimes misses the calibration point. *Id*. at 6.

The claim language does not support a construction that allows the pointing line to pass near the calibration point without touching it. The term "pass through" indicates that the pointing line must at least touch the calibration point in order to pass through it. The inclusion of "substantially," however, indicates that the pointing line need not be entirely within the

Case: 15-1297 Document: 23 Page: 161 Filed: 03/30/2015

calibration point. There need only be some overlap of the pointing line and the calibration point. Indeed, the specification in Figure 18 illustrates the point of aim (shown as a light spot 210) at the end of the pointing line as mostly, but not wholly, within the area of the calibration point. Thus, including "touches" properly gives effect to the pointing line being "largely but not wholly" within the calibration point. Accordingly, "substantially pass through" is construed as "directing said pointing line such that it touches said calibration point."

"pointing line"

The term "pointing line" appears in Claims 5, 6, 12, 15, 19, 20, 23, 25, and 44 of the '321 Patent. Defendants propose "a line that extends along the axis of the pointing device in the direction of pointing." Plaintiff proposes "a line that extends in the direction of pointing." The dispute centers on whether the pointing line necessarily coincides with the axis of the pointing device.

Defendants contend that their construction provides the necessary precision contemplated by the specification. Dkt. No. 238, at 13. Defendants argue that under Plaintiff's construction, the pointing line could extend from any number of positions, thus it is imprecise. *Id*. Plaintiff contends that Defendants' construction improperly imports a limitation, "along the axis of," that is only present in a preferred embodiment. Dkt. No. 227, at 8.

The claims only require that the pointing line have a predetermined relation to a pointing device. '321 Patent, 34:7–8. Further, the specification only recites that the pointing line "*may* substantially coincide with the long axis of the pointing device." *Id.*, 7:6–10 (emphasis added). Thus, "pointing line" is construed as "a line that extends in the direction of pointing."

"calibration points"

The term "calibration point(s)" appears in Claims 6, 15, 19, 20, 23, 25, 33, 34, 37, 44, 51, and 52 of the '321 Patent and Claims 5, 6, and 12 of the '729 Patent. Defendants propose "a point having a predetermined position relative to the interaction region and used in calibration." Plaintiff proposes "a calibration point is a location for use in establishing a relationship between the point of aim of the pointing device and the computer-generated image."

The claims also employ "first point" and "second point" in reference to "calibration points." The term "first point" appears in Claims 27, 31, 32, and 47 of the '321 Patent and Claim 1 of the '729 Patent. The term "second point" appears in Claim 32 of the '321 Patent and Claim 1 of the '729 Patent. Defendants propose construing "first point" and "second point," like "calibration point," as "a point having a predetermined position relative to the interaction region and used in calibration." Plaintiff contends that "first point" and "second point" do not require a separate construction.

Plaintiff argues that the claims already specify that a "calibration point" is a point having a predetermined relation to a computer-generated image. Dkt. No. 227, at 9. Plaintiff contends that the specification also indicates that a "calibration point" establishes the relationship between the pointing device's point-of-aim and the computer-generated image. *Id.*

Defendants contend that calibration points are used in calibration because they are only referenced in the context of the calibration routine. Dkt. 238 at 21. Defendants argue that the calibration points necessarily have a predetermined position in the interactive region because the calibration routine establishes the relationship between the point-of-aim of the pointing device and the interaction structure. *Id.*

The claim language defines a "calibration point" as a point having a predetermined relation to the image generated by the computer. '321 patent, 35:55–60. Therefore, the claim context provides sufficient guidance as to the meaning of the term and no construction is necessary for "calibration point." Since "first point" and "second point" are "calibration points," these additional terms do not require construction, either.

"calibration"

The term "calibration" appears in Claims 6, 15, 19, 20, 23, 25, 27, 31–34, 37, 44, 51, and 52 of the '321 Patent and Claims 5, 6, and 12 of the '729 Patent. Defendants propose "the process of determining the shape, position, size, and orientation of the interaction region relative to a base coordinate system." Plaintiff argues that "calibration" does not require a separate construction from the terms in which it appears or, in the alternative, that the construction should be "the process of establishing a relationship between the point of aim of the pointing device and the computer-generated image." The issue is whether "calibration" needs to be construed.

Defendants argue that "calibration" needs a separate construction in order to understand the compound terms "calibration point" and "calibration data." Dkt. No. 238, at 13. Defendants also contend that the patentee defined "calibration" in the specification and in distinguishing the prior art. *Id*.

Plaintiff argues that the term "calibration" only appears in the contexts of "calibration point" and "calibration data" and does not need to be separately construed. Dkt. No. 227, at 8. Plaintiff contends that, in the alternative, "calibration" should be construed simply as the process of determining the relationship between the point-of-aim and the "calibration points." *Id*.

Case 6:11-cv-00496-LED Document 268 23 Filed 03/30/2015 Page 163 of 174

As discussed above, the claims define "calibration points" as "points in a predetermined relationship to the image." '321 patent, 35:55. Accordingly, no construction is necessary for "calibration" apart from the terms in which it appears.

"non-calibration point"

The term "non-calibration point" appears in Claims 15, 19, 20, 23, 25, 33, 34, 37, 44, 51, and 52 of the '321 Patent. Defendants argue that this term is not enabled for lack of written description, therefore it should not be construed. Plaintiff proposes "a location at which the pointing device is directed after calibration has been performed."

UltimatePointer contends that the ordinary meaning of the term indicates a point that is not a calibration point. Dkt. No. 227, at 12. Further, UltimatePointer argues that the order of recitation of "first and second spatial states" indicates that the term describes a point that is not a calibration point and is a location on the image that is pointed at after collecting data from a calibration point. *Id*.

Defendants contend that the term is not enabled because the specification does not use the term, therefore one of ordinary skill in the art would not be able to practice the claimed invention. Dkt. No. 238, at 17. Defendants also argue that, under Plaintiff's proposed construction, a "non-calibration point" would be an infinite expanse of locations. *Id*.

The term "non-calibration point" is used with its plain and ordinary meaning, a point that is not a calibration point. It is unnecessary to import the limitation of "a location pointed at after calibration has been performed," as such limitation is not required by the claim language. Therefore, the term "non-calibration point" is construed as "a point that is not a calibration point."

Case: 15-1297 Document: 23 Page: 165 Filed: 03/30/2015

“calibration data”

The term “calibration data” appears in Claims 27, 32–34, 51, and 52 of the ‘321 Patent. Defendants propose “data used in calibration.” Plaintiff proposes “data obtained when the pointing device [of claims 27, 32] or handheld enclosure [of claims 33, 34, 51, 52] is directed towards a calibration point during calibration.”

Plaintiff contends that “calibration data” refers to data that is generated, determined, or developed at a specific time. Dkt. No. 227, at 14. Thus, Plaintiff contends that the data is “obtained” when the pointing device is directed toward a calibration point. *Id*. Plaintiff also argues that Defendants’ proposed construction improperly incorporates Defendants’ construction of “calibration.” *Id*. at 15.

According to Defendants, the specification characterizes the “calibration data” as being used during calibration to establish the interaction structure. Dkt. No. 238, at 18. Defendants contend that, unlike their proposed construction, Plaintiff’s proposed construction only describes how the data is obtained without requiring that the data actually be used. *Id*. at 19.

The claims specify that calibration data is “indicative of a first spatial state of the pointing device.” ’321 Patent, 36:40–41. The claims provide the metes and bounds of the term, therefore, there is no need to import extraneous limitations or construe the term further. *Phillips*, 415 F.3d at 1314.

“non-calibration data”

The term “non-calibration data” appears in Claims 33, 34, 37, 51, and 52 of the ‘321 Patent. Plaintiff proposes “data obtained when the handheld enclosure is directed towards a non-calibration point at a time after calibration.” Defendants argue this term is not enabled for lack of written description.

Plaintiff contends the term is understood, described, and enabled, as the specification describes data obtained when the device is pointed at non-calibration points. Dkt. No. 227, at 16. Plaintiff further argues that the claim language and ordinary English support their construction, as the term is defined to mean data that is not calibration data. *Id*. at 15.

Defendants again contend that there is a lack of a written description and enablement because the term does not expressly appear in the specification. Dkt. No. 238, at 19.

The claims specify that "non-calibration data" is "data related to said enclosure being directed towards a non-calibration point." '321 Patent, 37:42–43. Again, the claims provide the metes and bounds of the term. Therefore, there is no need to import extraneous limitations or construe the term further. *Phillips*, 415 F.3d at 1314.

"data indicative"/"data related" and related terms

The term "[first/second] *data indicative* of a [first/second] spatial state of said enclosure" appears in Claims 15, 19, 20, 23, and 25 of the '321 Patent. Defendants propose "[first/second] data that indicates a [first/second] spatial state of the enclosure." Plaintiff proposes "data that is a sign or indication of the [first/second] spatial state of the enclosure."

There are several related terms that turn on the same construction. First, "first calibration *data indicative* of a first spatial state of said enclosure" appears in Claims 27, 31, and 32 of the '321 Patent. Defendants propose "first calibration data that indicates a first spatial state of said enclosure." Plaintiff proposes "calibration data that is sign or indication of the first spatial state of the enclosure."

Second, "first calibration *data related* to said enclosure being directed towards said first calibration point" appears in Claims 33, 34, and 37 of the '321 Patent. Defendants propose "first calibration data representing or indicating the spatial state of the enclosure when the enclosure is

being directed towards a first calibration point." Plaintiff argues that no construction is necessary.

Finally, the term "first calibration *data* when the user input device *indicates* that the enclosure is being directed towards a first calibration point" appears in Claims 51 and 52 of the '321 Patent. Defendants propose "first calibration data that indicates the spatial state of the enclosure when the user input device shows that the enclosure is directed toward a first calibration point." Plaintiff contends that no construction is necessary. The dispute for all these terms revolves around the component term "data indicative/related."

Plaintiff contends that the term "indicative" means a sign or indication. Dkt. No. 227, at 17. Plaintiff argues that, by contrast, Defendants' constructions merely substitute similar words. *Id*. at 18. Further, Plaintiff argues that the term does not require that the spatial state be *completely* defined or determined. Dkt. No. 247, at 6–7.

Defendants contend that the term means that the spatial state is shown or defined by first calibration data. Dkt. No. 238, at 20. Accordingly, Defendants argue that Plaintiff's construction is overly broad in only requiring some generalization of the orientation of the enclosure. *Id*. at 20–21. Defendants argue that the specification makes clear that the spatial state of the enclosure is fully defined in order for the presentation system to properly operate. *Id*. at 21.

The claims specify that the calibration data is used to indicate the spatial state of the pointing device. '321 Patent, 36:37–53. Further, the spatial state of the enclosure is fully defined by the calibration data. '321 Patent, 38:46–51. Thus, Defendants' proposal of "calibration data that indicates/represent[s] the spatial state of the enclosure" more accurately reflects the meaning of the term as it is used in the context of the claimed subject matter. Accordingly, the terms are construed as follows: "[first/second] date indicative of a [first/second] spatial state of said

enclosure" is construed as "[first/second] data that indicates a [first/second] spatial state of the enclosure"; "first calibration data indicative of a first spatial state of said enclosure" is construed as "first calibration data that indicates a first spatial state of said enclosure"; and "first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point" is construed as "first calibration data that indicates the spatial state of the enclosure when the user input device shows that the enclosure is directed toward a first calibration point." Finally, the term "first calibration data related to said enclosure being directed towards said first calibration point" is construed as "first calibration data representing or indicating the spatial state of the enclosure when the enclosure is being directed towards a first calibration point."

"sensing device"

The term "sensing device" appears in Claims 15, 19, 20, 23, 25, 27, 31–33, 37, 44, 47, 51, and 52 of the '321 Patent. Defendants propose "a device that measures physical properties." Plaintiff proposes "a device having one or more sensors that detect or measure something." The dispute revolves around two issues: (1) whether the construction should specify that the sensing device can include more than one sensor, and (2) whether the sensor "detects" as well as "measures."

Plaintiff argues that a construction including "one or more sensors" is supported by claims that require "at least one of" several type of sensors. Dkt. No. 227, at 18. Plaintiff also contends that the construction should not be limited to "measures" because the dictionary defines the term as measure or detect. *Id*.

Defendants argue that the specification provides that the sensing device measures the three-dimensional position and orientation of the pointing device, and that all the exemplar

Case: 15-1297 Document: 23 Page: 169 Filed: 03/30/2015

sensors in the specification measure physical properties. Dkt. No. 238, at 22. Thus, the specification supports construing this term as a device that measures physical properties. *Id*.

The claims specifically define when one or more sensors are included in the sensing device. *See* ‘321 Patent, 38:5–8 (Claim 37, “said sensing device includes at least one of [the listed sensors]”); *cf.* 36:34 (Claim 25, “said sensing device includes an image sensor”). Thus, it is not necessary to import the limitation of “one or more sensors” to the term’s construction. As to whether the sensing device detects and measures, the claims specify that the sensor “senses” the spatial state of a handheld enclosure. ‘321 Patent, 35:54–55. The spatial state of the enclosure refers to its physical orientation, thus the sensor measures a physical property. Moreover, each exemplar sensor type (for example, accelerometer, gravity sensor, magnetic field sensor, gyroscope, image sensor, inclinometer) measures a physical property. ‘321 Patent 35:54–60, 36:12–15. Therefore, “sensing device” is construed as “a device that measures physical properties.”

“sensor data”

The term “sensor data” appears in Claims 44, 47, 51, and 52 of the ‘321 Patent. Defendants propose construing this term as “data output by a sensor.” Plaintiff proposes “data provided by a sensor or sensing device.” The dispute turns on whether the sensor data can be provided by a sensing device as well as by a sensor.

Plaintiff argues that the claims recite that sensor data may be provided by the sensing device. Dkt. No. 227, at 19. Defendants respond that, while some claims do indicate that sensor data may be provided by the sensing device, the specification reveals that this sensor data is output from a sensor. Dkt. No. 238, at 22.

The Parties' proposals evidence that there is consensus that the data may be provided by a sensor. The only dispute is whether the data may also be provided by a sensing device. The claim language of Claims 44, 47, and 51 specifies "a sensing device which provides sensor data." '321 Patent, 38:59, 39:21, 40:17–18. Therefore, it is inherent in the claim language that the data may be provided by the sensing device. Since the claims provide the metes and bounds of the term, no further construction is necessary.

"control"

The term "control" appears, as "control," "controlling," or "controlled" (collectively, "control" terms), in Claims 5, 6, 12, 15, 27, 33, 44, 47, 51, and 52 of the '321 Patent and Claims 1, 3, 5, 6, and 12 of the '729 patent. Defendants argue that no construction is necessary or, in the alternative, they propose "directly regulate[ing/ed] or directly influence[ing/ed]." Plaintiff proposes "influence[ing/ed], manage[ing/ed], or regulate[ing/ed]." The dispute turns on whether the control is necessarily direct control.

Plaintiff contends that "control" is used with its ordinary meaning of "influence, manage, or regulate" and that Defendants' proposed construction inserts a superfluous limitation with the word "direct." Dkt. No. 227 at 19.

Defendants contend no construction is necessary. Dkt. No. 238, at 22. Further, Defendants contend that Plaintiff's proposed construction improperly broadens the "control" terms to include both indirect regulation and indirect influence. *Id.* at 23. Defendants argue that all the illustrative embodiments show a feature on an image that is directly dictated. *Id.*

The "direct" aspect of the control is inherent in the claim language. For example, Claim 15 provides that "the feature of the image can be controlled based on the relation between the first spatial state and the second spatial state of [the] enclosure." '321 patent, 35:65–68. The

claim describes control of the feature by movement of the enclosure. Additionally, the context of the claims shows that "control" is being used with its plain meaning. Therefore, the claims provide the metes and bounds of the term, and "control" does not need to be further construed.

"control data"

This term appears in Claims 15, 19, 20, 23, 25, 33, 34, and 37 of the '321 Patent. Defendants propose "values computed that directly regulate or directly influence the coordinates of the feature." Plaintiff proposes "data used to influence, manage, or regulate a feature on the image." The dispute, similar to the term "control," hinges on whether there is direct control.

Plaintiff contends that the term carries the ordinary meaning conveyed by the constituent words "control" and "data." Dkt. No. 227, at 20. Plaintiff argues that Defendants' construction improperly adds a "directly" requirement that is not supported by the claim language. *Id*. Further, Plaintiff argues that the limitation to "values computed" is also without basis. *Id*.

Defendants contend that control data is specifically developed to control the features on an image and that it does not include the data used to develop the first calibration data. Dkt. No. 238, at 23. Defendants argue that several different types of data can "influence, manage, or regulate" a feature on an image and that defining control data in this manner would effectively read "control" out of the claim. *Id*.

As discussed above, the claim language itself imposes a "directly" limitation, so it is not necessary to include such limitation in the term's construction. Further, the claims distinguish between "control data" and "spatial state" data. Whereas spatial-state data is the "raw" data provided to the communication element, "control data" is processed data. Defendants' proposal of "values computed," however, represents a narrower limitation than processed data. Therefore, the appropriate construction for the term "control data" is "processed spatial state data."

Case: 15-1297 Document: 23 Page: 172 Filed: 03/30/2015

"distance"/ "data related to the distance"

The term "the distance between the first point and the second point" appears in Claims 1 and 3 of the '729 Patent. Defendants propose "the separation between the first and second points." Plaintiff argues that no construction is needed.

A related term, "*data related to* the distance between a first and a second point," also appears in the same claims. Defendants propose construing this second term as "data that permits the calculation of the distance between a first and a second point." Plaintiff again argues that no construction is necessary for this term. In both cases, the dispute revolves around whether it is necessary to construe the word "distance."

Plaintiff contends that no construction is needed for either term because "distance" is used in its ordinary sense. Dkt. No. 227, at 22. Defendants contend that these terms should be construed to clarify their plain and ordinary meanings. Dkt. 238, at 24. Further, Defendants argue that the specification uses the term "distance" in the context of the physical separation between two points. *Id*.

Substituting "separation" for "distance" provides no meaningful guidance as to the meaning of the term. Further, including a "calculation of the distance" adds an extraneous limitation nowhere found in the claims. These terms employ the word "distance" with its common and ordinary meaning. Therefore, no construction is necessary for these terms.

"data of the calibration points"

The term "data of the calibration points" appears in Claims 5, 6, and 12 of the '729 Patent. Defendants propose "sensor data obtained in the process of calibration." Plaintiff proposes "data generated from detecting the calibration points."

According to Plaintiff, the claims specify that the data is generated by the image sensor and relates to the calibration points. Dkt. No. 227, at 22. Further, Plaintiff argues that the specification describes the execution of a calibration sequence and the determination of the position of the calibration points. *Id*. at 22–23. Plaintiff contends that the data generated by the sensor as it detects the calibration points is the "data of the calibration points." *Id*. at 22. Plaintiff argues that Defendants' construction improperly includes an unspecified calibration process. *Id*. at 23.

Defendants contend the claim language requires that the data of the calibration points be generated by the image sensor. Dkt. No. 238, at 25. Therefore, data of the calibration points should be restricted to "sensor data." *Id*.

The claims recite that there are "calibration points provided in a predetermined relationship to the [computer generated] image." *See*, *e.g*., '729 Patent, 34:28–29. Thus, the term "data of the calibration points" carries the plain meaning of "data that is indicative of the relationship of the calibration points to the image." Furthermore, the claims clearly specify that the data of the calibration points is provided by a sensor. *Id.* at 34:32–33. Therefore, "data of the calibration points" is construed as "sensor data that is indicative of the relationship of the calibration points to the image."

"spatial relation between"/"relation between"

The term "spatial relation between the image and the pointing device located at said first position" appears in Claims 27, 31, and 32 of the '321 Patent. Defendants propose "the physical relationship between the image and the pointing device at a first location determined by the spatial state of the pointing device relative to the image." Plaintiff proposes "the physical

relationship between the image and the pointing device when the pointing device is located at the first position."

A related term, "relation between the first spatial state and second spatial state of the enclosure," appears in Claims 15, 19, 20, 23, 25, and 44 of the '321 Patent. Defendants propose "the relationship between the enclosure's spatial state at two different times, determined by comparing the enclosure's two spatial states." Plaintiff proposes "the relationship between the enclosure's spatial state at two different times, determinable by comparing the enclosure's two spatial states." For both terms, the dispute centers on whether the construction should include the method of determining the spatial relationship.

Plaintiff contends there is agreement on "spatial relation between" except as to Defendants' improper limitation of the term to a particular method of determining that relationship. Dkt. No. 227, at 23–24. Plaintiff also argues that Defendants' construction of "relation between" improperly requires the method of determining the relationship rather than the mere capability of determining it. *Id*. at 24.

Defendants contend that their construction is supported by the claims, which set forth that a determination of the spatial relationship of the image and the pointing device is made by comparing their spatial states. Dkt. No. 238, at 26.

The claims provide no basis for including a limitation regarding the specific method of determining the recited spatial relation. Providing a specific method would impermissibly mix method steps in apparatus claims. Both proposed constructions include "the physical relationship between the image and the pointing device." Nothing more is needed. Accordingly, the terms are construed as "the physical relationship between the image and the pointing device."

"orientation [of said enclosure]"

The term "orientation" appears in Claim 20 of the '321 Patent and Claims 3, 6, and 12 of the '729 Patent. Defendants propose "pitch, roll, and yaw." Plaintiff argues no construction is required, or, in the alternative, that the construction should be "alignment in space."

A related term, "orientation of said enclosure," appears in Claim 20 of the '321 Patent and a related term, "orientation of said [the] handheld device," appears in Claims 3, 6, and 12 of the '729 Patent. Defendants propose construing these two terms as "the pitch, roll, and yaw of the enclosure [handheld device]." Plaintiff argues no construction is necessary, or, in the alternative, that the construction should be "the alignment of the enclosure [handheld device] in space."

The issue is whether it is necessary to provide a technical definition of "orientation." Plaintiff argues that no construction is required because "orientation" is used with its plain and ordinary meaning. Dkt. No. 227, at 24. Alternatively, Plaintiff contends the term only means that there is alignment in space. *Id*. at 25. Plaintiff argues that Defendants' constructions use terms that are not used anywhere in the patent. *Id*. Defendants contend the term "orientation" is used in the context of geometry. Dkt. No. 238, at 26. Based on that context, Defendants argue that their constructions are consistent with the specification. *Id*. at 27.

The term "orientation" is a common and easily understood term. The term is used with its ordinary meaning. Construing orientation as "pitch, roll, and yaw" would not further clarify the term or give guidance to the jury. Therefore, no construction is necessary for this term.

"feature on an image" and related terms

There are three disputed terms related to a "feature on an image." First, the term "feature on an image" appears in Claims 15, 19, 20, 23, 25, 33, 34, 37, 44, 47, 51, and 52 of the '321

Patent. Second, the term "feature on *the* image" appears in the same claims of the '321 Patent, as well as Claims 1, 3, 5, 6, and 12 of the '729 Patent. Third, the term "feature on a *computer generated* image" appears in Claims 1, 3, 5, 6, and 12 of the '729 Patent. Defendants propose construing these terms as "object on an image." Plaintiff proposes "an element, part, or constituent of the computer-generated image that appears on the display screen, such as a character, an item of sporting equipment, a weapon, a cursor/pointer, a menu item, a button, a vehicle, as examples." The principal dispute is whether it is necessary to clarify the word "feature."

Plaintiff contends that the meaning of feature is broader than "object." Dkt. No. 227, at 25. Thus, Plaintiff faults Defendants' proposed construction of "feature" as "object" for being overly limiting. *Id*. Defendants argue that "object" is an appropriate construction because all the examples in the specification recite objects used as cursors, including a virtual pen and a virtual gun. Dkt. No. 238, at 27–28.

The patent specification illustrates a "feature" with a cursor that is not part of an underlying displayed image. '321 Patent, 28:38–44. Thus, a construction that defines the feature as part of the image is not supported. Additionally, "object on an image" does not clarify the term. Other than stating that "object" encompasses all the examples named in the patent for "feature," Defendants fail to explain how "object" would be more helpful to the jury. The term "feature on an image" is easily understood. Thus, no construction is necessary for this term.

"image sensor"

The term "image sensor" appears in Claims 25, 31, and 37 of the '321 Patent and Claims 1, 3, 5, 6, and 12 of the '729 Patent. Defendants propose construing this term as "a device that

senses data from an image." Plaintiff proposes "a sensing device able to capture an image." The dispute turns on whether an image sensor necessarily captures an image to gather data from it.

Plaintiff contends that one of skill in the art would understand "image sensor" to mean a sensor that captures an image. Dkt. No. 227, at 26. Plaintiff also argues that Defendants' proposed construction reads "image" out of the claim and broadens it to "data." *Id*.

Defendants contend that their construction is consistent with the specification, which they characterize as showing a sensor that obtains information from an image but does not capture the image. Dkt. No. 238, at 28. Further, Defendants point to the express distinction in the specification between "image sensor" and "image capture devices." *Id*. Defendants contend that Plaintiff's construction is driven by an attempt to avoid "light gun" prior art. *Id*. at 28–29.

Plaintiff's characterization of the image sensor's functionality as image "capture" suggests it is a camera-like device that is taking a picture. However, the term "image capturing device, such as a digital camera" is separately identified in the '321 Patent, 29:7–9. Instead, the claims describe a sensing device that includes an image sensor to generate spatial-state data by sensing coordinates. *Id*. at 7:2–8. The specification identifies Charge Coupled Devices (CCDs) as a sensing device for coordinate sensing. *Id*. at 7:18–21. A CCD senses an image by focusing light reflected from an object forming the image onto a detector and measuring the intensity of the light across the imaged area. Therefore, "image sensor" is construed as "a device that measures the intensity of reflected light from an image."

"coupled to"

The term "coupled to" appears in Claims 15, 19, 20, 23, 25, 27, 31–34, and 37 of the '321 Patent. Defendants propose "electrically connected to." Plaintiff proposes "joined or associated in a manner to permit information or signals to be communicated, either wirelessly or through

conductors." The parties dispute whether the connection is necessarily wired, or whether it can also be wireless.

Plaintiff seeks a dictionary definition for this term. Dkt. No. 227, at 29. Plaintiff argues that Defendants' construction wrongly conveys that there is a physical, wired connection to the exclusion of wireless coupling. *Id.* at 29. Defendants, on the other hand, contend that their construction is supported by the context of the electrical connections shown in the specification. Dkt. No. 238, at 30.

The specification, in the illustration of pointing device 20, supports a communication element. '321 Patent, Fig. 1. There, the communication device 204 of pointing device 20 is described separately from coordinate sensing device 201. *Id.* at 7:2–8, 7:51–59. However, there is no schematic diagram showing the "coupling" of the sensing device 201 to the communication device 204. Instead, each of the identified types of sensing devices provides its output electrical signals via conductors. Consequently, the communication device 204 is necessarily electrically connected, with or without a wire, to the sensing device 201. *Id.* at 7:53–56. Therefore, the construction of the term "coupled to" in the context of the '321 patent is "electrically connected either directly or indirectly."

MOTIONS FOR SUMMARY JUDGMENT OF INDEFINITENESS

Defendants move for summary judgment of invalidity for indefiniteness under 35 U.S.C. 112 ¶2. For the reasons set forth below, the Court **GRANTS IN PART** and **DENIES IN PART** the motion for summary judgment.

APPLICABLE LAW

"Summary judgment is appropriate in a patent case, as in other cases, when there is no genuine issue as to any material fact and the moving party is entitled to judgment as a matter of law." *Nike Inc. v. Wolverine World Wide, Inc.*, 43 F.3d 644, 646 (Fed. Cir. 1994); FED. R. CIV. P. 56(c). The moving party bears the initial burden of "informing the district court of the basis for its motion" and identifying the matter that "it believes demonstrate[s] the absence of a genuine issue of material fact." *Celotex Corp. v. Catrett*, 477 U.S. 317, 323, 106 S. Ct. 2548, 2553 (1986). If the moving party meets this burden, the nonmoving party must then set forth "specific facts showing that there is a genuine issue for trial." FED. R. CIV. P. 56(e); *see also T.W. Elec. Serv., Inc. v. Pacific Elec. Contractors Ass'n*, 809 F.2d 626, 630 (9th Cir. 1987).

A party seeking to invalidate a patent must overcome a presumption that the patent is valid. *See* 35 U.S.C. § 282; *Microsoft Corp. v. i4i Ltd. Partn'p*, 564 U.S. __, 131 S. Ct. 2238, 2243 (2011); *United States Gypsum Co. v. National Gypsum Co.,* 74 F.3d 1209, 1212 (Fed. Cir. 1996). This presumption places the burden on the challenging party to prove the patent's invalidity by clear and convincing evidence. *Microsoft,* 131 S.Ct. at 2243; *United States Gypsum Co.,* 74 F.3d at 1212. Close questions of indefiniteness "are properly resolved in favor of the patentee." *Datamize, LLC v. Plumtree Software, Inc.*, 417 F.3d 1342, 1348 (Fed. Cir. 2005); *Exxon Research & Eng'g Co. v. United States*, 265 F.3d 1371, 1380 (Fed. Cir. 2001).

Claims must particularly point out and distinctly claim the invention. "The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the

subject matter which the applicant regards as his invention." 35 U.S.C. § 112 ¶ 2. The primary purpose of the requirement of definiteness is to provide notice to those skilled in the art of what will constitute infringement. *See United Carbon Co. v. Binney Co.,* 317 U.S. 228, 236 (1942). The definiteness standard is one of reasonableness under the circumstances, requiring that, in light of the teachings of the prior art and the invention at issue, the claims apprise those skilled in the art of the scope of the invention with a reasonable degree of precision and particularity. *See Shatterproof Glass Corp. v. LibbeyOwens Corp.,* 758 F.2d 613, 624 (Fed. Cir. 1985). To rule "on a claim of patent indefiniteness, a court must determine whether one skilled in the art would understand what is claimed when the claim is read in light of the specification." *Bancorp Servs., L.L.C. v. Hartford Life Ins. Co.*, 359 F.3d 1367, 1372 (Fed. Cir. 2004). "A determination of indefiniteness is a legal conclusion that is drawn from the court's performance of its duty as the construer of patent claims, [and] therefore, like claim construction, is a question of law." *Amtel Corp. v. Info. Storage Devices, Inc.,* 198 F.3d 1374, 1378 (Fed. Cir. 1999).

A single claim that recites two separate statutory classes of invention, e.g., "an apparatus and a method of using that apparatus," renders the claim indefinite under 35 U.S.C. § 112 ¶2. *IPXL Holdings, L.L.C. v. Amazon.com, Inc.*, 430 F.3d 1377, 1384 (Fed. Cir. 2005). The problem with mixing apparatus and method steps is that such mixed claims fail to clarify "whether infringement would occur when one creates a system that allows the user to [perform the step] . . . or . . . when the user actually [performs the step]." *HTC Corp. v. IPCom GmbH & Co., KG*, 667 F.3d 1270, 1277 (Fed. Cir. 2012). "[S]uch a claim 'is not sufficiently precise to provide competitors with an accurate determination of the "metes and bounds" of protection involved' and is 'ambiguous and properly rejected.'" *Id.* (quoting *Ex parte Lyell*, 17 U.S.P.Q.2d 1548 (1990)). However, apparatus claims that are limited by functional language are not necessarily

Case: 15-1297 Document: 23 Page: 181 Filed: 03/30/2015

indefinite. *Microprocessor Enhancement Corp. v. Texas Instruments Inc.*, 520 F.3d 1367, 1375 (Fed. Cir. 2008) (citing *Halliburton Energy Servs. v. M-I LLC*, 514 F.3d 1244, 1255 (Fed. Cir. 2008)). If the functional language of the claim merely describes "the structure and capabilities of the claimed apparatus," then the claim is sufficiently definite under 35 U.S.C. § 112 ¶2. *SynQor, Inc. v. Artesyn Techs., Inc.*, 2010 U.S. Dist. LEXIS 74808, at *97 (E.D. Tex. July 26, 2010), *aff'd SynQor v. Artesyn Techs. Inc.*, No. 2011-1192 (Fed. Cir. March 13, 2013) (citing *Microprocessor*, 520 F.3d at 1375).

ANALYSIS

Defendants contend that Claims 15, 19, 20, 23, 25, 27, 31–34, 37, 44, 47, 51, and 52 improperly mix method steps with systems limitations in the same claim. Dkt. No. 243. Plaintiff contends that each of these claims merely uses functional language to describe the system's capabilities. Dkt. No. 250.

Claims 33, 34, and 37

Independent claim 33 reads as follows:

> An apparatus for controlling a feature on an image generated by a computer, comprising:
> [a] a handheld enclosure including a sensing device which provides data;
> [b] a user input device to indicate that said enclosure *is being directed towards a first calibration point*, said first calibration point having a predetermined relation to the image; and
> [c] a processor coupled to said sensing device and said user input device and programmed to provide control data for controlling the feature on the image, said processor *using data provided by said sensing device to develop first calibration data related to said enclosure being directed towards said first calibration point* and *non-calibration data related to said enclosure being directed towards a non-calibration point*, said processor further *using said first calibration data and said non-calibration data to develop said control data*.

'321 Patent, 37:28–45 (numeration and emphasis added). Claims 34 and 37 depend from Claim 33. *Id.* at 37:46–55, 38:5–8.

Defendants contend the claim recites both an apparatus and an action performed by a user. Dkt. No. 243, at 6–7. Defendants argue that element [b] recites a "user input device . . . being directed towards a first calibration point" and element [c] recites a processor that "is using data provided . . . by [a] sensing device." *Id.* at 6. Defendants argue that the "directed towards" language describes an action to be performed by the user. *Id.* at 7. Defendants further argue that the data used by the processor cannot exist absent action by the user. *Id.*

Plaintiff responds that the language is merely describing the functions of the claimed user-input device and processor. Dkt. No. 250, at 2. Plaintiff argues that the apparatus claimed has the capability to use data provided by the sensing device to develop calibration data related to the handheld enclosure, if and when it is directed toward a point. *Id.* at 3–4.

The specification describes the user-input device as a button 203 or 204, which button, when pressed, indicates that the handheld enclosure is being directed to a calibration point. '321 patent, 12:17–24. Thus, element [b] of the claim recites a structure defined by its function of indicating when the enclosure is aimed at a calibration point. Similarly, element [c] recites that the processor receives data from the sensing device and is programmed to develop calibration and non-calibration data. *Id*. at 37:36–45. Therefore, element [c] is a structure defined according to its function of using data to develop control data "for controlling the feature of an image." As the apparatus claimed does not impermissibly mix method steps, but uses functional language, Claim 33, and its dependents, are sufficiently definite under 35 U.S.C. § 112 ¶2. *IPXL Holdings*, 430 F.3d at 1384.

Claims 27, 31, and 32

Independent claim 27 reads as follows:

> An apparatus for determining a spatial relation between a computer generated image and a user-wielded pointing device, comprising:

Case: 15-1297 Document: 23 Page: 183 Filed: 03/30/2015

[a] a sensing device for generating first calibration data indicative of a first spatial state of the pointing device, said sensing device being at least partly contained in the pointing device;
[b] a user input device to indicate that the pointing device is located at a first position and directed towards a first point, said first point having a predetermined relation to the image; and
[c] a processor coupled to said sensing device and said user input device and programmed to use said first calibration data to determine the spatial relation between the image and the pointing device located at said first position,
[d] wherein the spatial relation is provided to control a feature on the image.

'321 patent, 36:37–53 (numeration added). Claims 31 and 32 are dependents of Claim 27. *Id.* at 37:14–27. Defendants mirror their arguments regarding Claim 33. Dkt. No. 243, at 9. In addition, Defendants argue that the "directed towards" language used in element [b] is not merely functional because the claim requires that the spatial relation of element [d] be used by the system. *Id.* at 9–10. Plaintiff again responds that the language at issue is merely describing the functions of the claimed user-input device and processor. Dkt. No. 250, at 6.

As stated above, the claim defines the structures according to their functions. Furthermore, element [d] recites no use by a user of the pointing device. Therefore, the same analysis as claim 33 applies. Claims 27, 31, and 32 are sufficiently definite under 35 U.S.C. § 112 ¶2.

Claims 44, 47, 51, and 52

Independent claim 44 reads as follows:

A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld enclosure which has a pointing line having a predetermined relation with the enclosure and a sensing device which provides sensor data, the method comprising:
[a] determining a first spatial state of the enclosure while the pointing line is directed at a first calibration point, said first calibration point having a predetermined relation to the image, based on received sensor data;

[b] determining a second spatial state of the enclosure while the pointing line is directed at a non-calibration point on the image based on received sensor data; and

[c] controlling the feature on the image based on the relation between the first spatial state and the second spatial state of the enclosure.

‘321 Patent, 38:54–39:3. Independent claim 47 reads as follows:

> A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld pointing device which has a sensing device which provides sensor data and the user input device to indicate that the pointing device is directed at a point, the method comprising:
>
> [a] determining a first spatial state of the pointing device based on received sensor data when the user input device indicates that the pointing device is located at a first position and directed towards a first point, said first point having a predetermined relation to the image; and
>
> [b] determining the spatial relation between the image and the pointing device located at said first position based on the first spatial state; and
>
> [c] controlling the feature on the image based on the first spatial state and the spatial relation.

‘321 Patent, 39:17–33. Independent claim 51 reads as follows:

> A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld enclosure which has a sensing device which provides sensor data and the user input device to indicate that the pointing device is directed at a point, the method comprising:
>
> [a] determining first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point, said first calibration point having a predetermined relation to the image, based on received sensor data;
>
> [b] determining non-calibration data when the enclosure is being directed towards a non-calibration point on the image based on received sensor data; and
>
> [c] controlling the feature on the image based on said first calibration data and said non-calibration data.

‘321 Patent, 40:14–30. Claim 52 is a dependent of Claim 51. *Id.* at 40:31–39. As with the claims previously discussed, Defendants argue that each claim requires a “computer readable medium” and a method step of “directing” a pointing device. Dkt. No. 243, at 13. Plaintiff argues that the claim simply uses functional language to describe the claimed apparatus. Dkt. No. 250, at 7.

Plaintiff contends that although the claims do recite method steps, they are simply functional steps that the computer must be capable of performing. *Id*.

Unlike the other claims challenged in Defendants' motion, this set of claims is directed to a computer-readable medium. These claims are so-called *Beauregard* claims, which is a generally accepted style for claiming a computer-readable medium containing program instructions for a computer to perform a particular process. *CyberSource Corp. v. Retail Decisions, Inc.*, 654 F.3d 1366, 1373 (Fed. Cir. 2011). A *Beauregard* claim, however, is considered to be directed to an apparatus, rather than to a method. M.P.E.P. 2106.1 (I). Therefore, Claims 44, 47, 51, and 52 do not evidence the impermissible mixing of apparatus and method claims held invalid as indefinite under *IPXL Holdings*. Consequently, Defendants' motion is denied as to claims 44, 47, 51, and 52.

Claims 15, 19, 20, 23, and 25

Independent claim 15 reads as follows:

> A pointing device for controlling a feature on an image generated by a computer, comprising:
> [a] a handheld enclosure having a predetermined relation to a pointing line;
> [b] a sensing device for generating first data indicative of a first spatial state of said enclosure while the pointing line is directed at a first calibration point, said first calibration point having a predetermined relation to the image, and for generating second data indicative of a second spatial state of said enclosure while the pointing line is directed at a non-calibration point on the image; and
> [c] a communication element coupled to said sensing device for providing control data to the computer for controlling the feature on the image, said control data being based on said first data and said second data,
> [d] wherein the feature on the image can be controlled based on the relation between the first spatial state and the second spatial state of said enclosure.

'321 Patent, 35:50–67. Claims 19, 20, 23, and 25 are dependents of Claim 15. *Id.* at 36:19–23, 33–34. Defendants contend that the claim recites a step performed by the user directing the pointing line at a calibration, or non-calibration, point because the user must be using the

pointing device for the sensing device to generate data “while the pointing line is directed at a . . . calibration point.” Dkt. No. 243, at 11. Plaintiff argues that this language merely describes the function and capability of the claimed “sensing device,” which is generating data, and does not require a user to direct the pointing line at any calibration or non-calibration point. Dkt. No. 250, at 5. Plaintiff contends that the claim is infringed when one makes, uses, sells, offers to sell, or imports a device having all the elements of the claim, including a sensing device that has the capability to generate data indicative of spatial states while the pointing line is directed at certain points. *Id.*

The clause at issue does not define the function of the sensing device. The function of the sensing device is simply to generate data indicative of the spatial state of the handheld enclosure. The pointing device structure, therefore, only consists of a handheld enclosure, a sensing device for generating data indicative of the spatial state of the handheld enclosure, and a communication element providing control data to the computer for controlling the feature on the image. Yet, the claim recites control of a feature on an image “based on the relation between the first spatial state and the second spatial state of the enclosure.” The relation between the spatial states depends on data generated “while the pointing line is directed at a . . . calibration point.” This requires the user to direct the handheld enclosure between two points, effectively requiring the user to use the pointing device.

Thus, the claim impermissibly mixes an apparatus and a method of using the apparatus as in *IPXL Holdings*. The claim is not definite as to whether the claim is infringed when the pointing-device apparatus is made or sold, or when a user actually uses it to direct a pointing line. *HTC Corp.*, 667 F.3d at 1277. Consequently, independent Claim 15 and its dependents,

Claims 19, 20, 23, and 25, are indefinite under 35 U.S.C. § 112 ¶2. Accordingly, Defendants' motion is **GRANTED IN PART** as to Claims 15, 19, 20, 23, and 25.

Summary

As to Claims 27, 31–34, 37, 44, 47, 51, and 52 of the '321 Patent, Defendants have failed to show by clear and convincing evidence that these claims are insoluble due to an impermissible mix of apparatus limitations and method steps. Accordingly, Defendants' motion for summary judgment of indefiniteness is **DENIED IN PART** as to Claims 27, 31– 34, 37, 44, 47, 51, and 52 of the '321 Patent. However, Defendants' motion for summary judgment of indefiniteness is **GRANTED IN PART** as to Claims 15, 19, 20, 23, and 25.

CONCLUSION

For the foregoing reasons, the Court interprets the claim language in this case in the manner set forth above. For ease of reference, the Court's claim interpretations are set forth in a table as Appendix A. Further, the Court hereby **GRANTS IN PART** Defendants' Motion for Summary Judgment of Invalidity Based on Indefiniteness under 35 U.S.C. 112 (Dkt. No. 243).

So ORDERED and SIGNED this 28th day of May, 2013.

LEONARD DAVIS
UNITED STATES DISTRICT JUDGE

APPENDIX A

Claim Term	Court's Construction
pointing device	direct-pointing device
handheld	No construction
handheld pointing device	handheld direct-pointing device
user-wielded pointing device	user-wielded direct-pointing device
using a parameter	No construction
projected computer screen image	computer screen image created by using beams of light directed through space to cause the image to fall onto a surface
point of aim	location at which the pointing line intersects with an object
directed at	pointed so that the point-of-aim intersects with
substantially pass through	directing said pointing line such that it touches said calibration point
pointing line	a line that extends in the direction of pointing
calibration	No construction
calibration points/first point/second point	No construction; defined in claims as "a point having a predetermined relation to the image generated by the computer"
non-calibration point	a point that is not a calibration point
calibration data	No construction
non-calibration data	No construction
[first/second] date indicative of a [first/second] spatial state of said enclosure	[first/second] data that indicates a [first/second] spatial state of the enclosure
first calibration data indicative of a first spatial state of said enclosure	first calibration data that indicates a first spatial state of said enclosure
first calibration data related to said enclosure being directed towards said first calibration point	first calibration data representing or indicating the spatial state of the enclosure when the enclosure is being directed towards a first calibration point
first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point	first calibration data that indicates the spatial state of the enclosure when the user input device shows that the enclosure is directed toward first calibration point
sensing device	a device that measures physical properties
sensor data	No construction
control/controlled/controlling	No construction
control data	processed spatial-state data
distance/data related to the distance	No construction
data of the calibration points	sensor data that is indicative of the relationship of the

Case: 15-1297 Document: 23 Page: 189 Filed: 03/30/2015

	calibration points to the image
spatial relation between/relation between	No construction
orientation [of said enclosure] /[handheld device]	No construction
feature on an/the image	No construction
image sensor	a device that measures the intensity of reflected light from an image
coupled to	electrically connected either directly or indirectly

US007746321B2

(12) **United States Patent**
Banning

(10) **Patent No.: US 7,746,321 B2**
(45) **Date of Patent: Jun. 29, 2010**

(54) EASILY DEPLOYABLE INTERACTIVE DIRECT-POINTING SYSTEM AND PRESENTATION CONTROL SYSTEM AND CALIBRATION METHOD THEREFOR

(76) Inventor: **Erik Jan Banning**, 5038 Creekbend Dr., Houston, TX (US) 77035

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1406 days.

(21) Appl. No.: **11/135,911**

(22) Filed: **May 24, 2005**

(65) **Prior Publication Data**

US 2005/0270494 A1 Dec. 8, 2005

Related U.S. Application Data

(60) Provisional application No. 60/575,671, filed on May 28, 2004, provisional application No. 60/644,649, filed on Jan. 18, 2005.

(51) **Int. Cl.**
G06F 3/033 (2006.01)

(52) **U.S. Cl.** **345/157**; 345/156

(58) **Field of Classification Search** 345/156–173
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,349,815	A	9/1982	Spooner
4,562,433	A	12/1985	Biferno
4,565,999	A	1/1986	King et al.
4,567,479	A	1/1986	Boyd
4,641,255	A	2/1987	Hohmann
4,654,648	A	3/1987	Herrington et al.
4,682,159	A	7/1987	Davison
4,682,195	A	7/1987	Yilmaz
4,730,186	A	3/1988	Koga et al.
4,745,402	A	5/1988	Auerbach
4,768,028	A	8/1988	Blackie
4,787,051	A	11/1988	Olson
4,796,019	A	1/1989	Auerbach
4,823,170	A	4/1989	Hansen
4,959,721	A	9/1990	Micic et al.
5,009,501	A	4/1991	Fenner et al.
5,023,943	A	6/1991	Heberle
5,045,843	A	9/1991	Hansen
5,047,754	A	9/1991	Akatsuka et al.

(Continued)

OTHER PUBLICATIONS

Mark S.D. Ashdown, "Personal projected displays", Mar. 2004, ISSN 1476-2986, pp. 83-87 (http://www.mark.ashdown.name/research/Ashdown-UCAM-CL-TR-585.pdf).

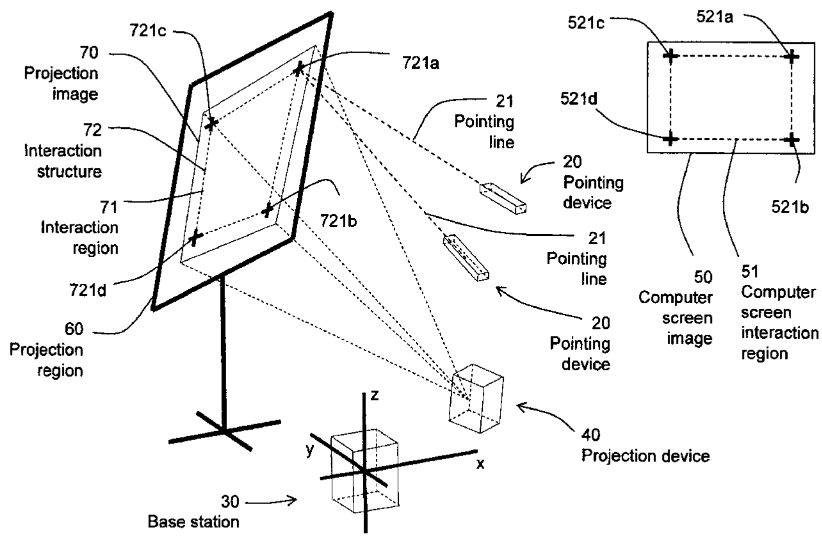
(Continued)

Primary Examiner—Nitin Patel
(74) *Attorney, Agent, or Firm*—Wong, Cabello, Lutsch, Rutherford & Brucculeri LLP

(57) **ABSTRACT**

A method for controlling movement of a computer display cursor based on a point-of-aim of a pointing device within an interaction region includes projecting an image of a computer display to create the interaction region. At least one calibration point having a predetermined relation to said interaction region is established. A pointing line is directed to substantially pass through the calibration point while measuring a position of and an orientation of the pointing device. The pointing line has a predetermined relationship to said pointing device. Movement of the cursor is controlled within the interaction region using measurements of the position of and the orientation of the pointing device.

53 Claims, 20 Drawing Sheets



U.S. PATENT DOCUMENTS

5,095,302	A	3/1992	McLean et al.	
5,231,674	A	7/1993	Cleveland et al.	
5,235,363	A	8/1993	Vogeley et al.	
5,262,777	A	11/1993	Low et al.	
5,274,363	A	12/1993	Koved et al.	
5,296,838	A	3/1994	Suzuki	
5,339,095	A	8/1994	Redford	
5,359,348	A	10/1994	Pilcher et al.	
5,367,315	A	11/1994	Pan	
5,394,360	A	2/1995	Fukumoto	
5,448,261	A	9/1995	Koike et al.	
5,469,193	A	11/1995	Giobbi et al.	
5,484,966	A	1/1996	Segen	
5,502,459	A	3/1996	Marshall et al.	
5,506,605	A	4/1996	Paley	
5,602,568	A	2/1997	Kim	
5,631,669	A	5/1997	Stobbs et al.	
5,638,092	A	6/1997	Eng et al.	
5,654,741	A	8/1997	Sampsell et al.	
5,668,574	A	9/1997	Jarlance-Huang	
5,734,371	A	3/1998	Kaplan	
5,793,354	A	8/1998	Kaplan	
5,796,386	A	8/1998	Lipscomb et al.	
5,883,616	A	3/1999	Koizumi et al.	
5,898,421	A	4/1999	Quinn	
5,898,424	A	4/1999	Flannery	
5,926,168	A *	7/1999	Fan	345/158
5,929,444	A	7/1999	Leichner	
5,952,996	A	9/1999	Kim et al.	
5,963,134	A	10/1999	Bowers et al.	
5,999,167	A	12/1999	Marsh et al.	
6,037,943	A	3/2000	Crone et al.	
6,067,085	A	5/2000	Modh et al.	
6,069,594	A	5/2000	Barnes et al.	
6,084,556	A	7/2000	Zwern	
6,104,380	A	8/2000	Stork et al.	
6,104,390	A	8/2000	Sturgeon et al.	
6,130,663	A	10/2000	Null	
6,130,664	A	10/2000	Suzuki	
6,171,190	B1	1/2001	Thanasack et al.	
6,184,863	B1	2/2001	Sibert et al.	
6,186,630	B1	2/2001	Miyashita	
6,212,296	B1	4/2001	Stork et al.	
6,271,831	B1	8/2001	Escobosa et al.	
6,275,214	B1	8/2001	Hansen	
6,292,171	B1 *	9/2001	Fu et al.	345/156
6,297,804	B1	10/2001	Kashitani	
6,326,979	B1	12/2001	Radeztsky	
6,335,723	B1	1/2002	Wood et al.	
6,342,878	B1	1/2002	Chevassus et al.	
6,353,434	B1	3/2002	Akebi	
6,373,961	B1	4/2002	Richardson et al.	
6,385,331	B2	5/2002	Harakawa et al.	
6,388,656	B1	5/2002	Chae	
6,400,139	B1	6/2002	Khalfin et al.	
6,404,416	B1	6/2002	Kahn et al.	
6,411,277	B1	6/2002	Shah-Nazaroff	
6,417,840	B1	7/2002	Daniels	
6,424,340	B1	7/2002	Holtzman et al.	
6,452,606	B1	9/2002	Luzzatto	
6,483,499	B1	11/2002	Li et al.	
6,492,981	B1	12/2002	Stork et al.	
6,504,526	B1	1/2003	Mauritz	
6,507,339	B1	1/2003	Tanaka	
6,520,647	B2	2/2003	Raskar	
6,529,186	B1	3/2003	Thayer	
6,545,661	B1	4/2003	Goschy et al.	
6,545,664	B1	4/2003	Kim	
6,558,002	B1	5/2003	Miyashita	
6,559,833	B2	5/2003	Rowe	
6,567,071	B1	5/2003	Curran et al.	
6,600,478	B2	7/2003	White et al.	
6,606,083	B1	8/2003	Murray et al.	
6,608,668	B2	8/2003	Gharib et al.	
6,642,918	B2	11/2003	Uchida et al.	
6,764,185	B1	7/2004	Beardsley	
6,877,863	B2	4/2005	Wood et al.	
7,091,949	B2 *	8/2006	Hansen	345/158
7,158,117	B2 *	1/2007	Sato et al.	345/158
7,158,118	B2	1/2007	Liberty	
7,239,301	B2	7/2007	Liberty et al.	
7,262,760	B2	8/2007	Liberty	
7,414,611	B2	8/2008	Liberty	
7,489,298	B2	2/2009	Liberty et al.	
2001/0010514	A1 *	8/2001	Ishino	345/158
2001/0043719	A1	11/2001	Harakawa et al.	
2001/0045940	A1 *	11/2001	Hansen	345/158
2002/0042699	A1	4/2002	Tanaka et al.	
2002/0075386	A1	6/2002	Tanaka	
2002/0079143	A1	6/2002	Silverstein et al.	
2002/0084980	A1	7/2002	White et al.	
2002/0085097	A1	7/2002	Colmenarez et al.	
2002/0089489	A1	7/2002	Carpenter	
2003/0006959	A1	1/2003	Varanda	
2003/0169233	A1 *	9/2003	Hansen	345/158
2003/0193572	A1	10/2003	Wilson	
2003/0222892	A1 *	12/2003	Diamond et al.	345/647
2004/0027328	A1 *	2/2004	Yang	345/156
2004/0070564	A1	4/2004	Dawson	
2004/0095317	A1	5/2004	Zhang	
2004/0233461	A1	11/2004	Armstrong et al.	
2004/0252102	A1	12/2004	Wilson	
2005/0091297	A1 *	4/2005	Sato et al.	708/442
2005/0093823	A1	5/2005	Hinckley et al.	
2005/0270494	A1	12/2005	Banning	
2007/0060383	A1	3/2007	Dohta	
2007/0066394	A1	3/2007	Ikeda et al.	
2007/0298882	A1	12/2007	Marks et al.	
2008/0136796	A1 *	6/2008	Dowling	345/204

OTHER PUBLICATIONS

Mark Ashdown, Peter Robinson; The Escritoire: A Personal Projected Display for Interacting With Documents; Technical Report; No. 538; University of Cambridge Computer Laboratory; Jun. 2002; UCAM-CL-TR-538; ISSN 1476-2986.

* cited by examiner

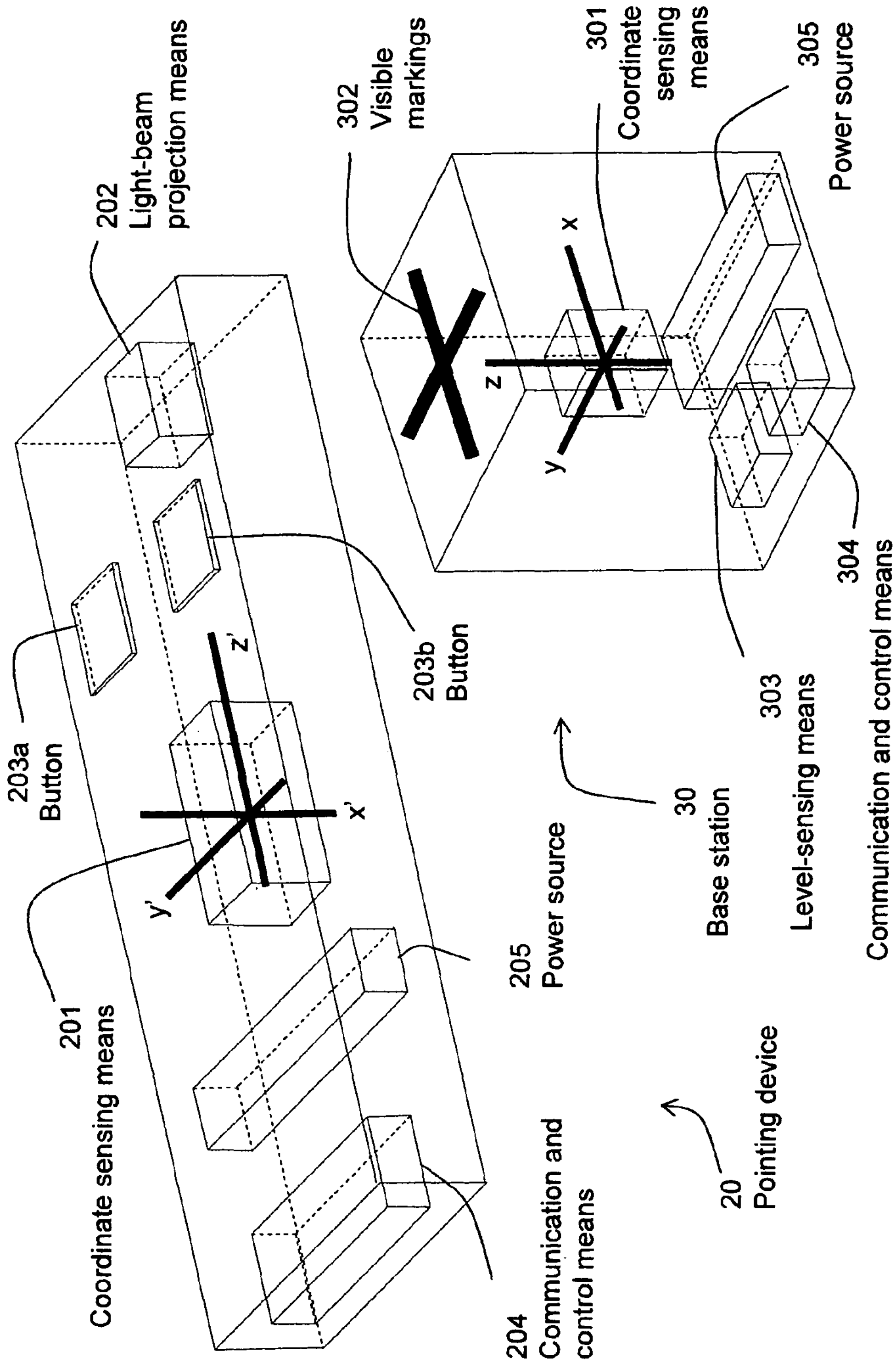

202
Light-beam
projection means
302
Visible
markings
301
Coordinate
sensing
means
305
Power source
x
z
y
203a
Button
z'
x'
y'
203b
Button
201
Coordinate sensing means
205
Power source
30
Base station
303
Level-sensing means
304
Communication and control means
204
Communication and
control means
20
Pointing device

Fig. 1

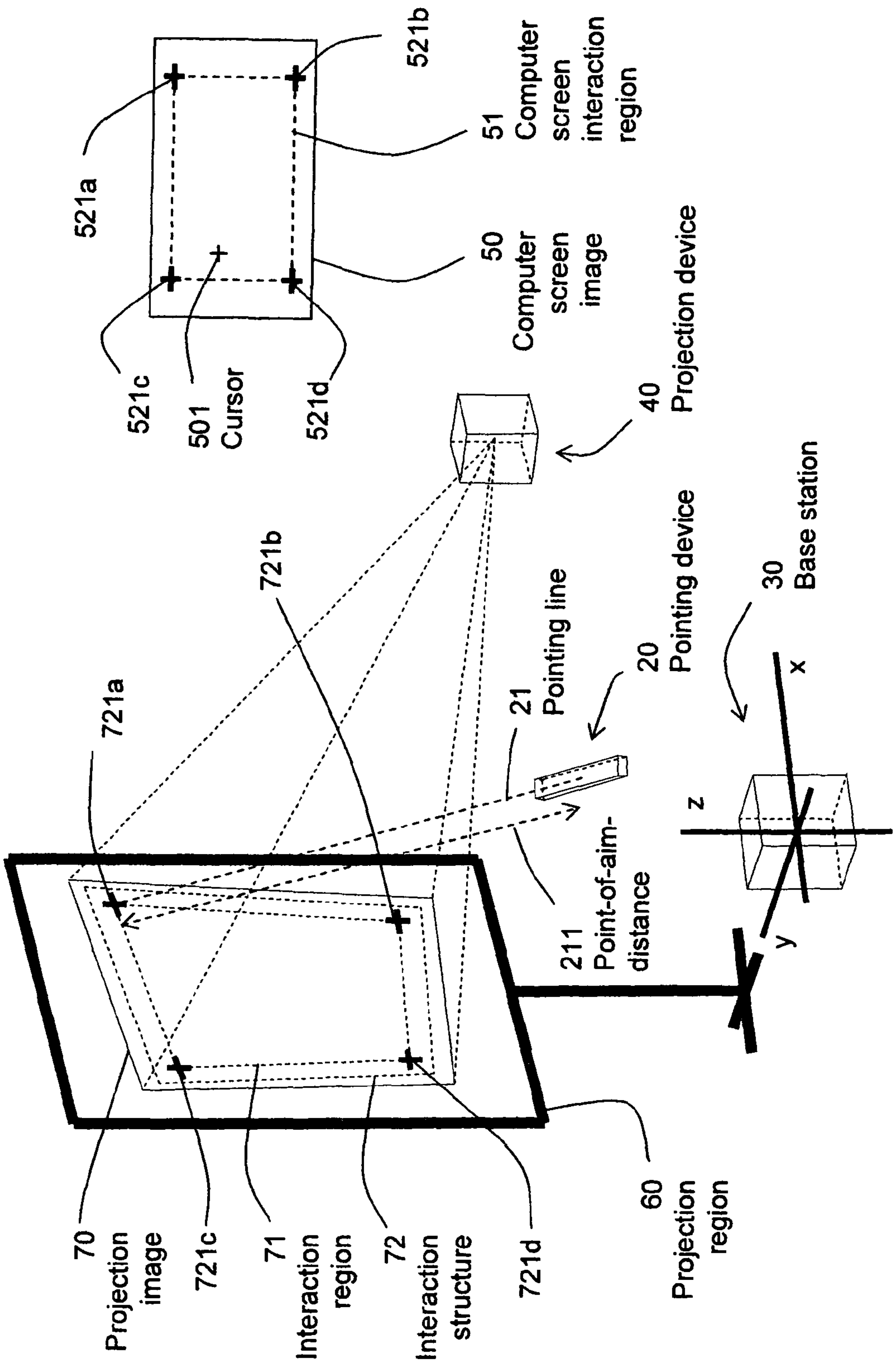

521a
521b
51 Computer screen interaction region
50 Computer screen image
521c
501 Cursor
521d
40 Projection device
721b
721a
21 Pointing line
20 Pointing device
30 Base station
x
z
y
211 Point-of-aim-distance
70 Projection image
721c
71 Interaction region
72 Interaction structure
721d
60 Projection region

Fig. 2

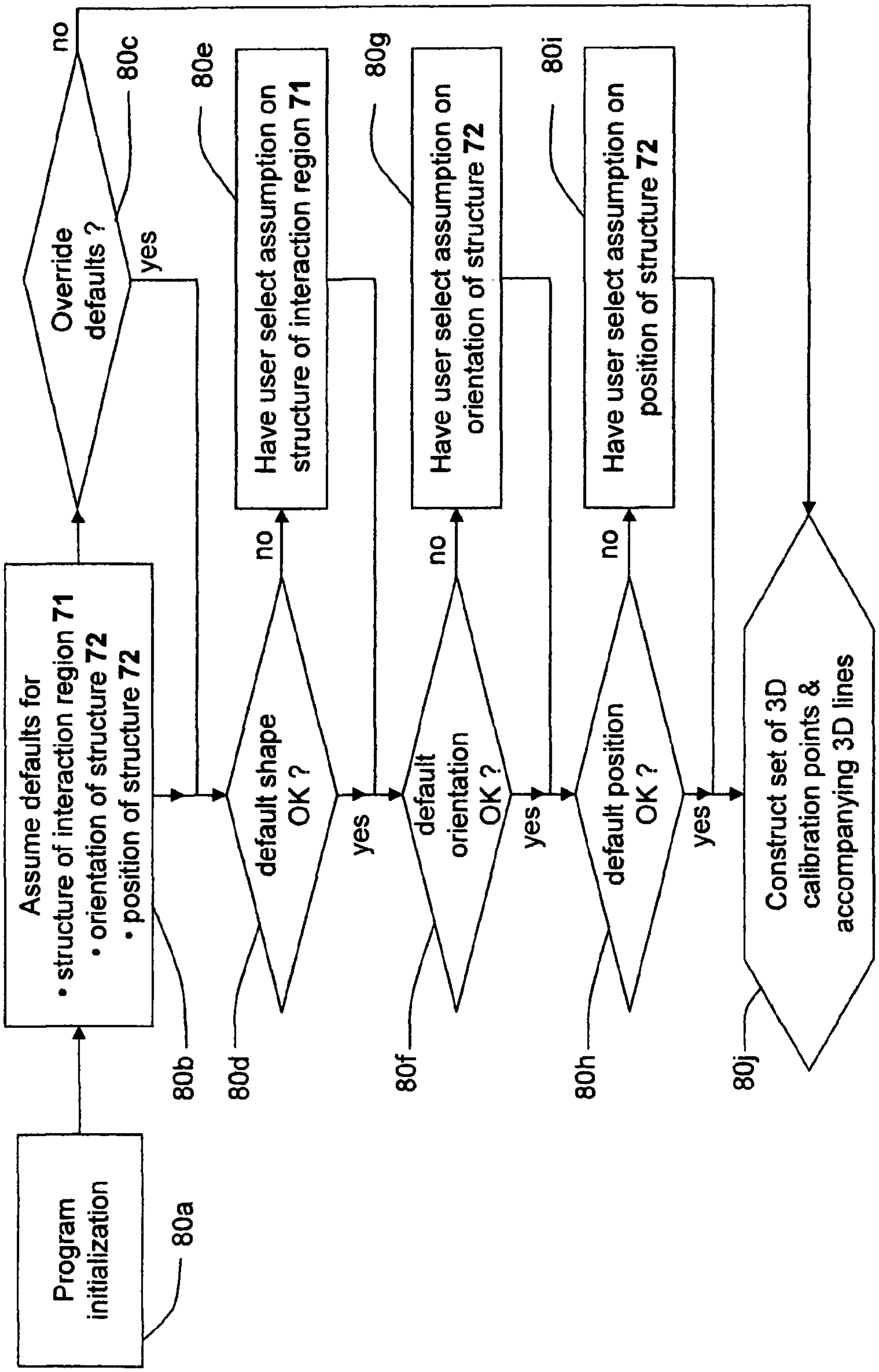

Program initialization
80a
Assume defaults for
• structure of interaction region **71**
• orientation of structure **72**
• position of structure **72**
80b
Override defaults ?
80c
no
yes
default shape OK ?
80d
no
yes
Have user select assumption on structure of interaction region **71**
80e
default orientation OK ?
80f
no
yes
Have user select assumption on orientation of structure **72**
80g
default position OK ?
80h
no
yes
Have user select assumption on position of structure **72**
80i
Construct set of 3D calibration points & accompanying 3D lines
80j

Fig. 3

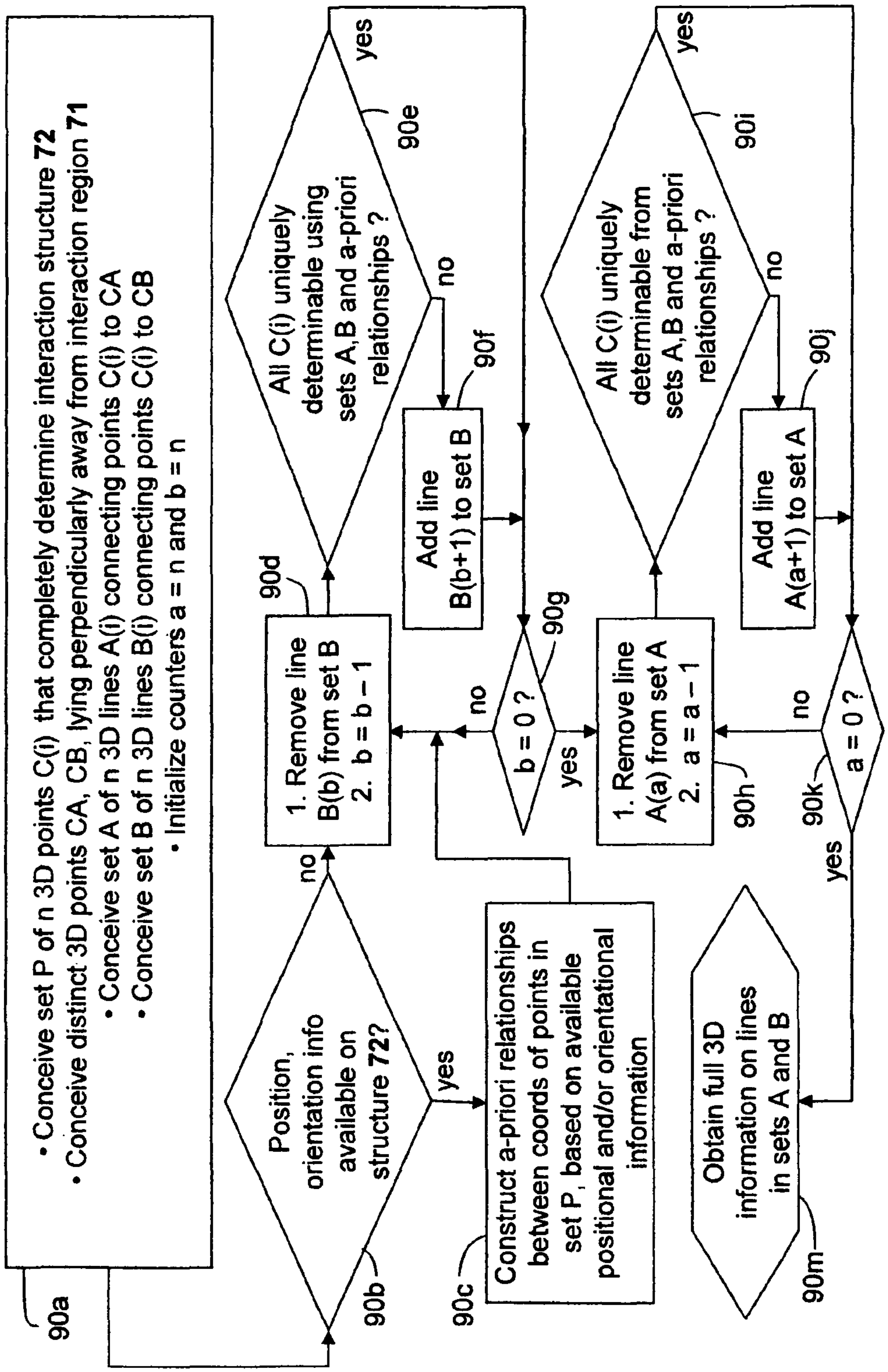

• Conceive set P of n 3D points C(i) that completely determine interaction structure 72
• Conceive distinct 3D points CA, CB, lying perpendicularly away from interaction region 71
• Conceive set A of n 3D lines A(i) connecting points C(i) to CA
• Conceive set B of n 3D lines B(i) connecting points C(i) to CB
• Initialize counters a = n and b = n
90a
Position, orientation info available on structure 72?
90b
yes
no
Construct a-priori relationships between coords of points in set P, based on available positional and/or orientational information
90c
1. Remove line B(b) from set B
2. b = b – 1
90d
All C(i) uniquely determinable using sets A,B and a-priori relationships ?
90e
yes
no
Add line B(b+1) to set B
90f
b = 0 ?
90g
no
yes
1. Remove line A(a) from set A
2. a = a – 1
90h
All C(i) uniquely determinable from sets A,B and a-priori relationships ?
90i
yes
no
Add line A(a+1) to set A
90j
a = 0 ?
90k
no
yes
Obtain full 3D information on lines in sets A and B
90m

Fig. 4

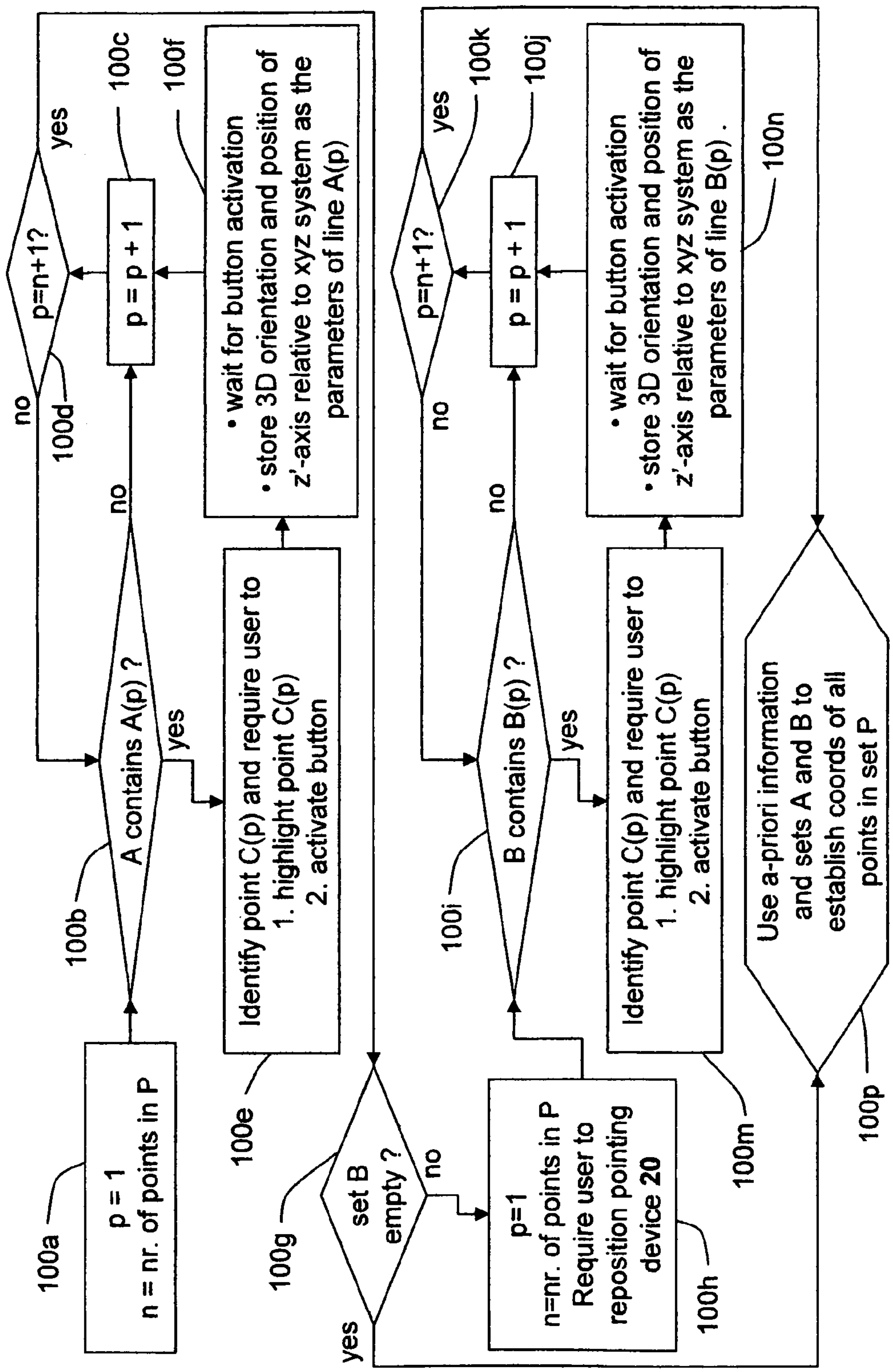

p = 1
n = nr. of points in P
100a
A contains A(p) ?
100b
yes
no
p = p + 1
100c
p=n+1?
100d
yes
no
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
100e
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p)
100f
set B empty ?
100g
yes
no
p=1
n=nr. of points in P
Require user to reposition pointing device 20
100h
B contains B(p) ?
100i
yes
no
p = p + 1
100j
p=n+1?
100k
yes
no
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
100m
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line B(p) .
100n
Use a-priori information and sets A and B to establish coords of all points in set P
100p

Fig. 5

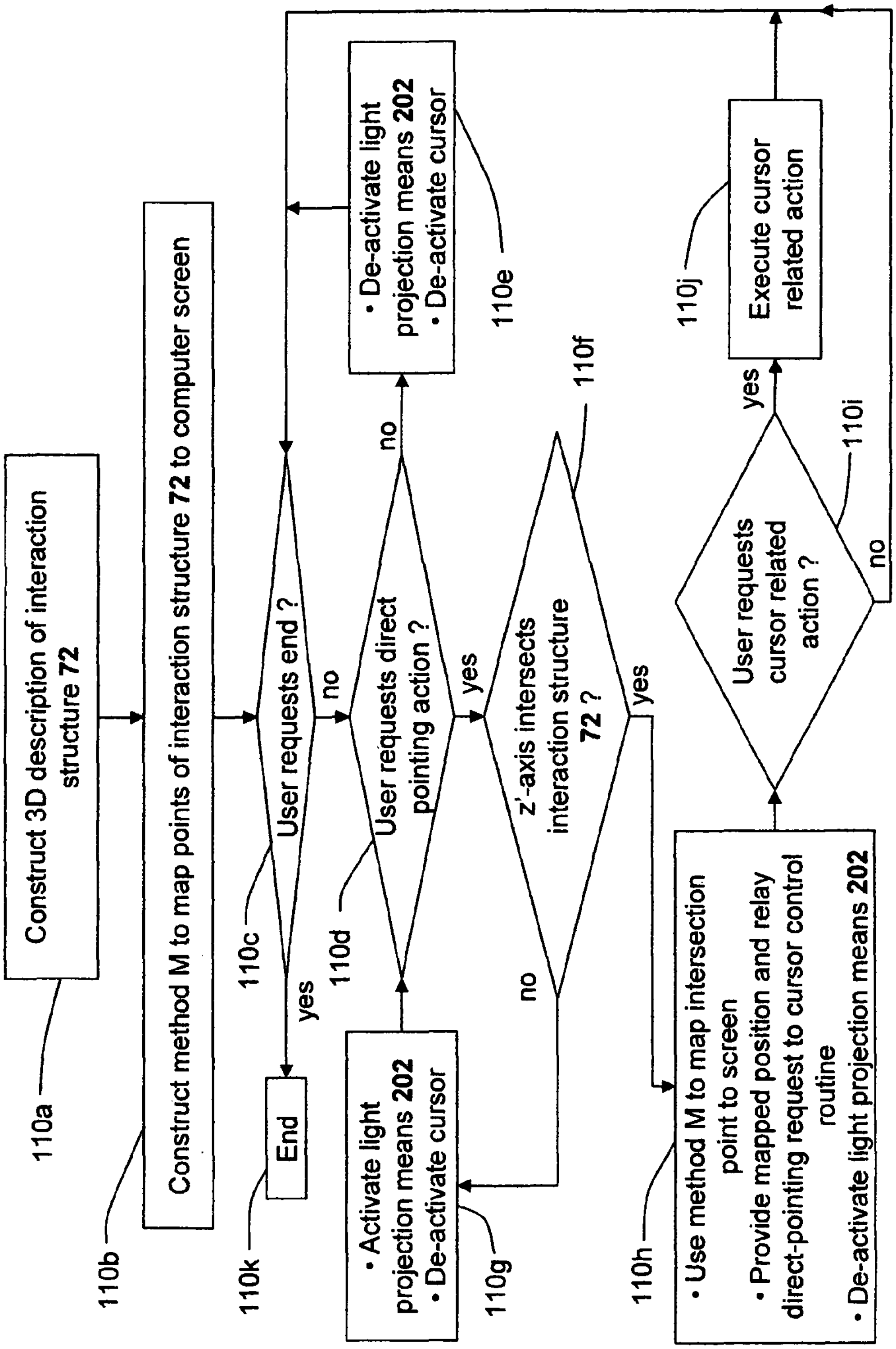

Construct 3D description of interaction structure 72
110a
Construct method M to map points of interaction structure 72 to computer screen
110b
User requests end ?
110c
yes
no
End
110k
User requests direct pointing action ?
110d
no
yes
• De-activate light projection means 202
• De-activate cursor
110e
• Activate light projection means 202
• De-activate cursor
110g
z'-axis intersects interaction structure 72 ?
110f
no
yes
• Use method M to map intersection point to screen
• Provide mapped position and relay direct-pointing request to cursor control routine
• De-activate light projection means 202
110h
User requests cursor related action ?
110i
yes
no
Execute cursor related action
110j

Fig. 6

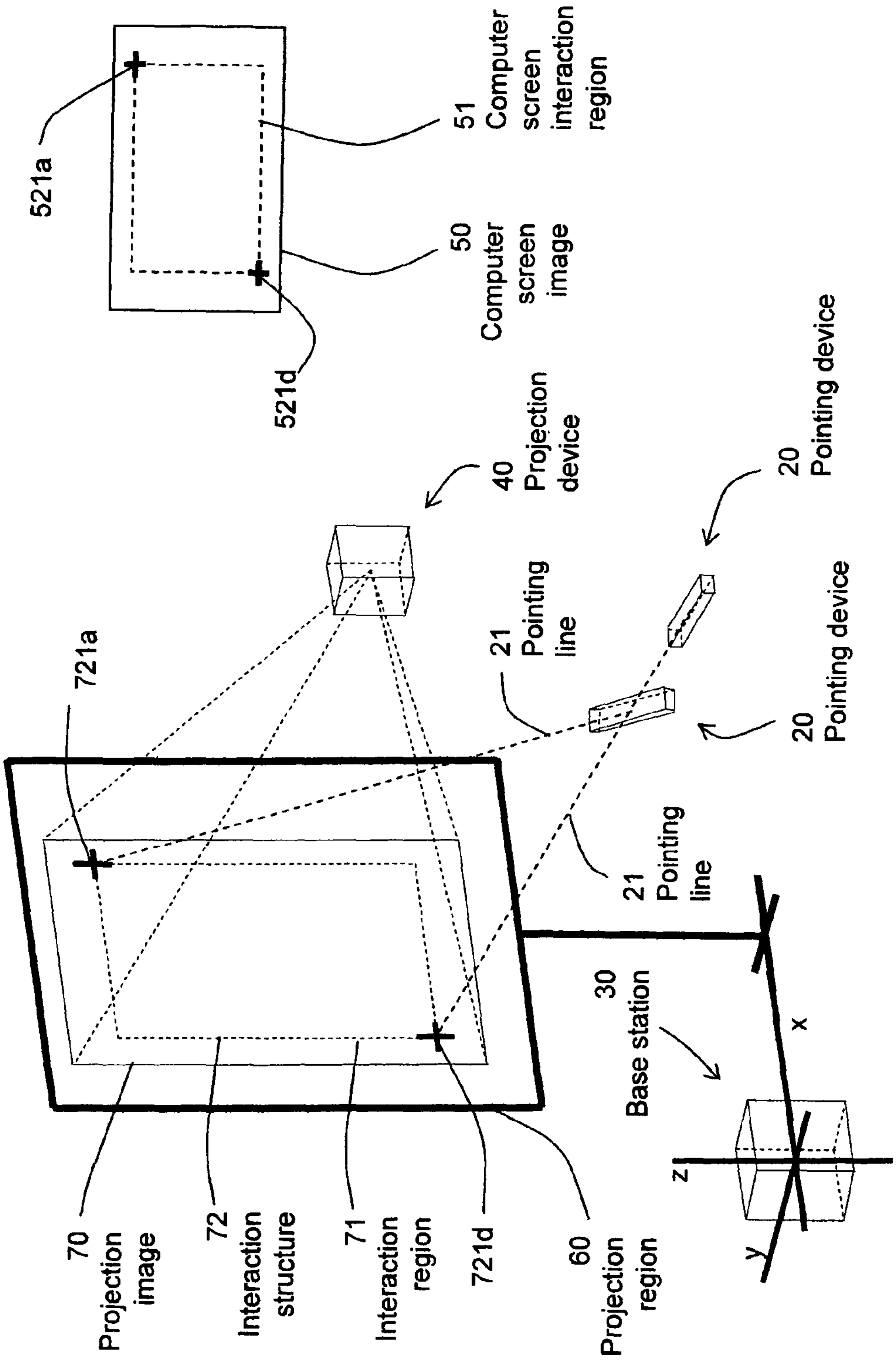

521a
51
Computer
screen
interaction
region
50
Computer
screen
image
521d
40
Projection
device
20
Pointing device
21
Pointing
line
20
Pointing device
721a
21
Pointing
line
30
Base station
x
z
y
70
Projection
image
72
Interaction
structure
71
Interaction
region
721d
60
Projection
region

Fig. 7

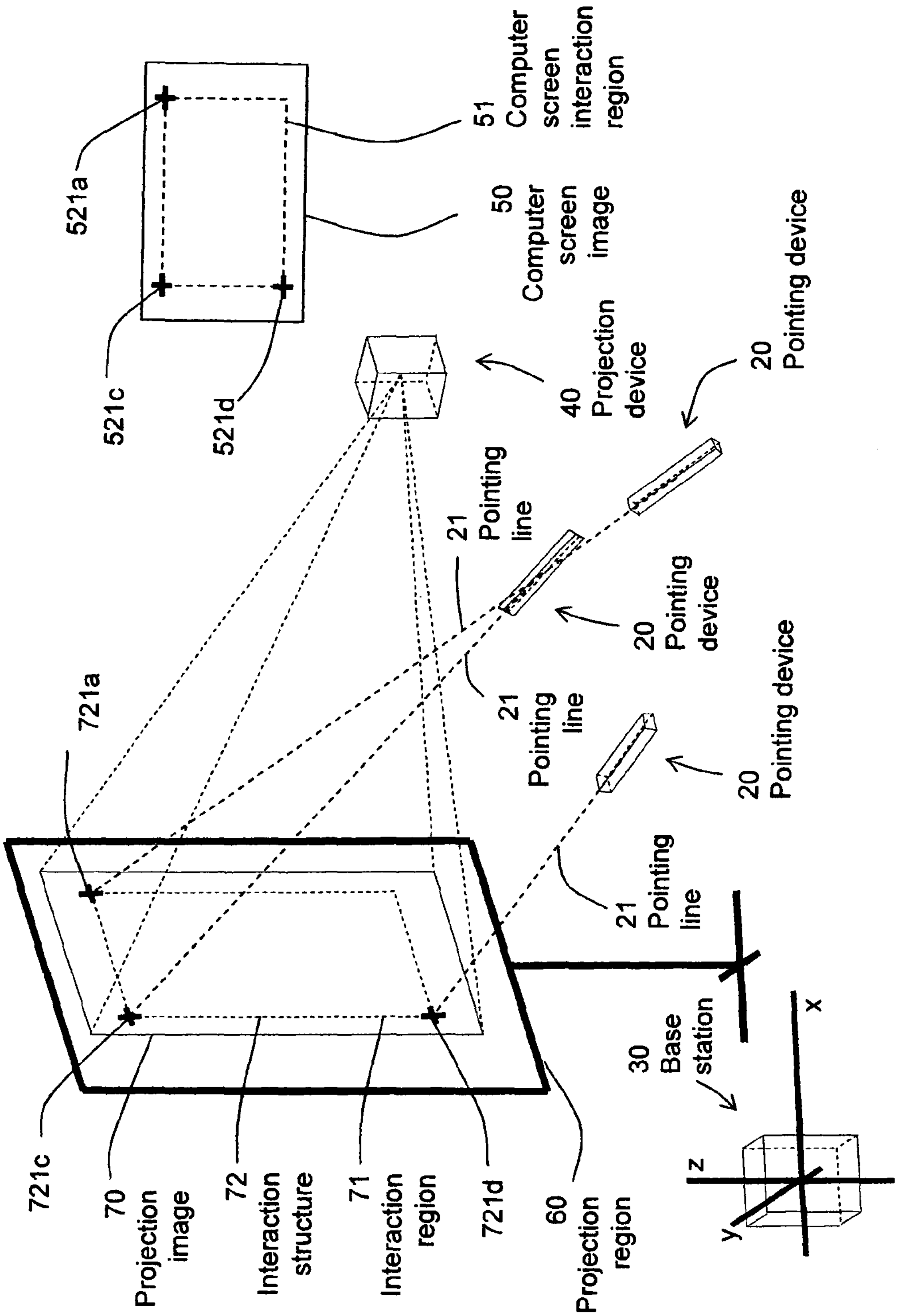

51 Computer screen interaction region
521a
50 Computer screen image
521c
521d
40 Projection device
20 Pointing device
21 Pointing line
20 Pointing device
21 Pointing line
20 Pointing device
21 Pointing line
721a
721c
70 Projection image
72 Interaction structure
71 Interaction region
721d
60 Projection region
30 Base station
x
y
z

Fig. 8

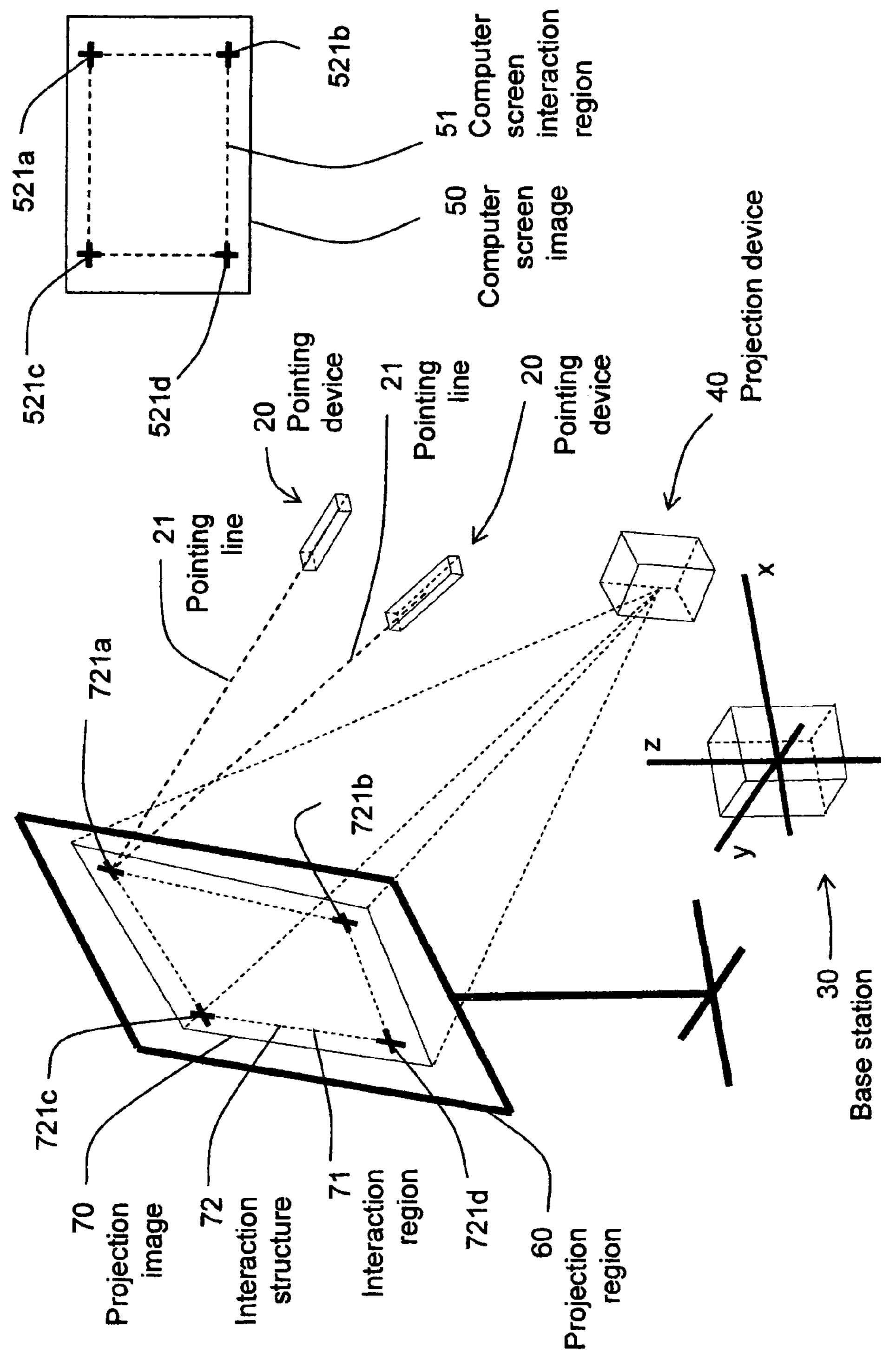

521a
521b
521c
521d
51 Computer screen interaction region
50 Computer screen image
20 Pointing device
21 Pointing line
21 Pointing line
20 Pointing device
40 Projection device
721a
721b
721c
721d
x
y
z
70 Projection image
72 Interaction structure
71 Interaction region
60 Projection region
30 Base station

Fig. 9

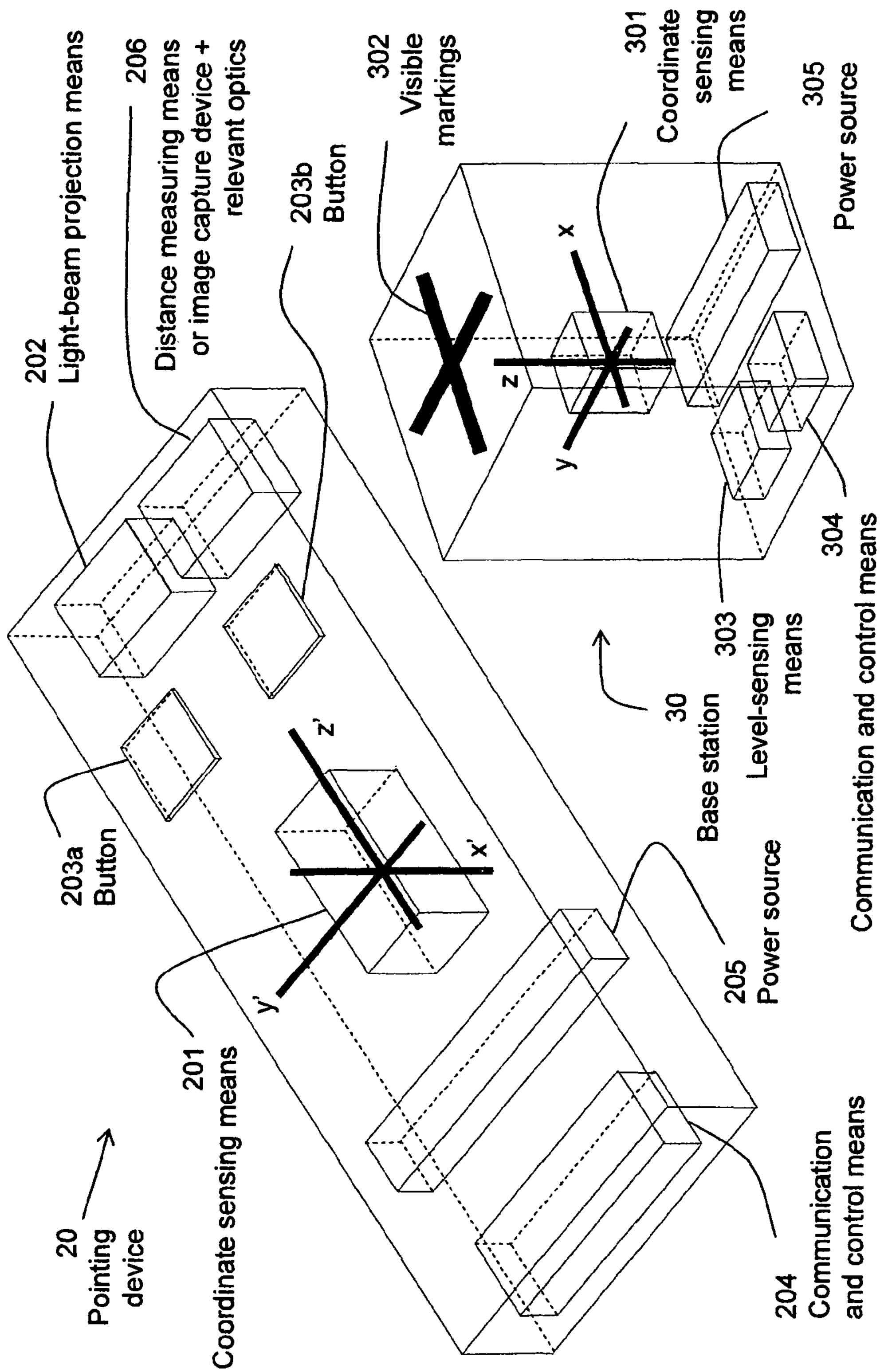
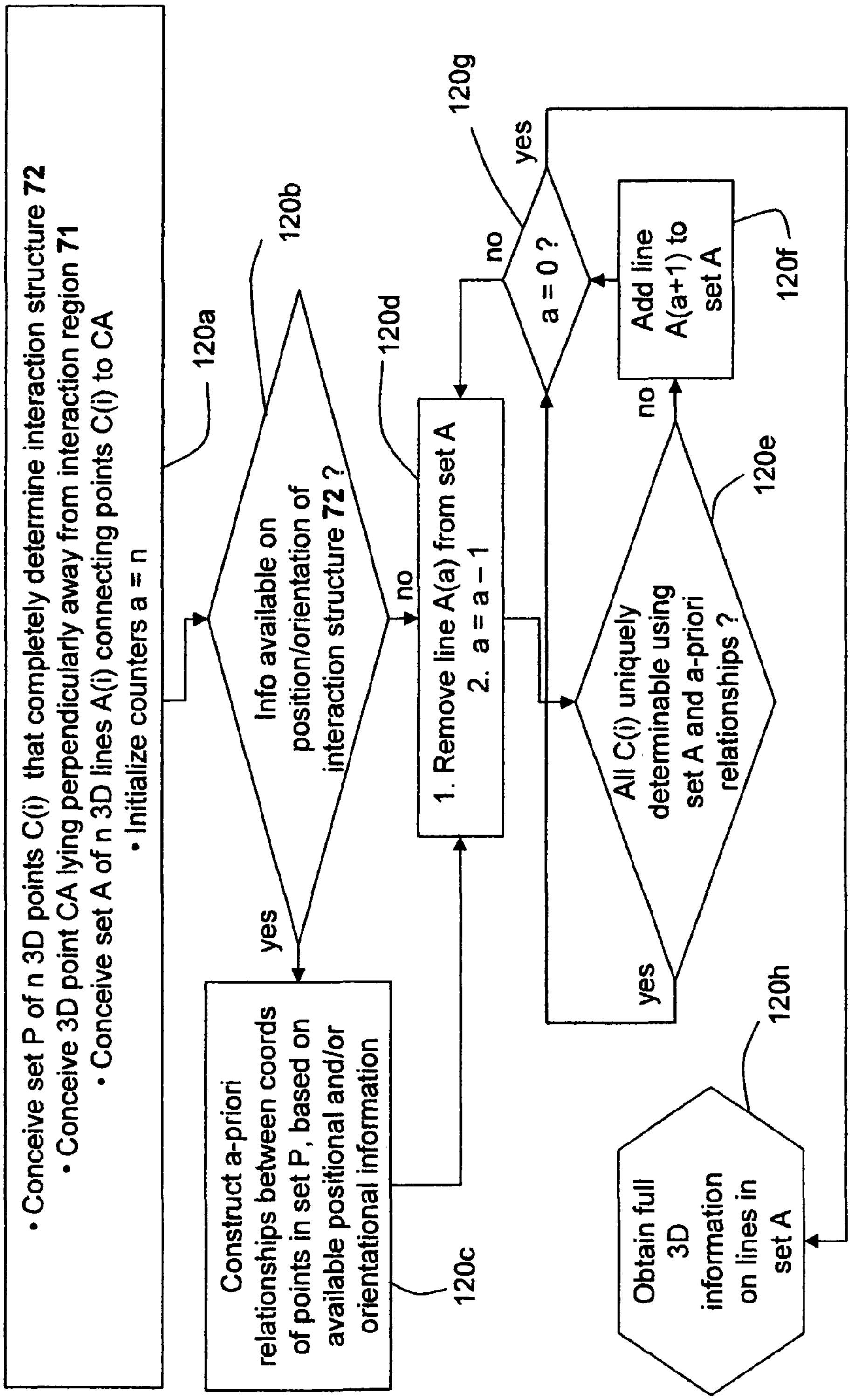

202
Light-beam projection means
206
Distance measuring means
or image capture device +
relevant optics
203b
Button
302
Visible
markings
301
Coordinate
sensing
means
305
Power source
z
x
y
z'
x'
y'
203a
Button
201
Coordinate sensing means
20
Pointing
device
30
Base station
303
Level-sensing
means
304
Communication and control means
205
Power source
204
Communication
and control means

Fig. 10



• Conceive set P of n 3D points C(i) that completely determine interaction structure **72**
• Conceive 3D point CA lying perpendicularly away from interaction region **71**
• Conceive set A of n 3D lines A(i) connecting points C(i) to CA
• Initialize counters a = n
120a
Info available on position/orientation of interaction structure **72** ?
120b
yes
no
Construct a-priori relationships between coords of points in set P, based on available positional and/or orientational information
120c
1. Remove line A(a) from set A
2. a = a – 1
120d
All C(i) uniquely determinable using set A and a-priori relationships ?
120e
yes
no
Add line A(a+1) to set A
120f
a = 0 ?
120g
no
yes
Obtain full 3D information on lines in set A
120h

Fig. 11

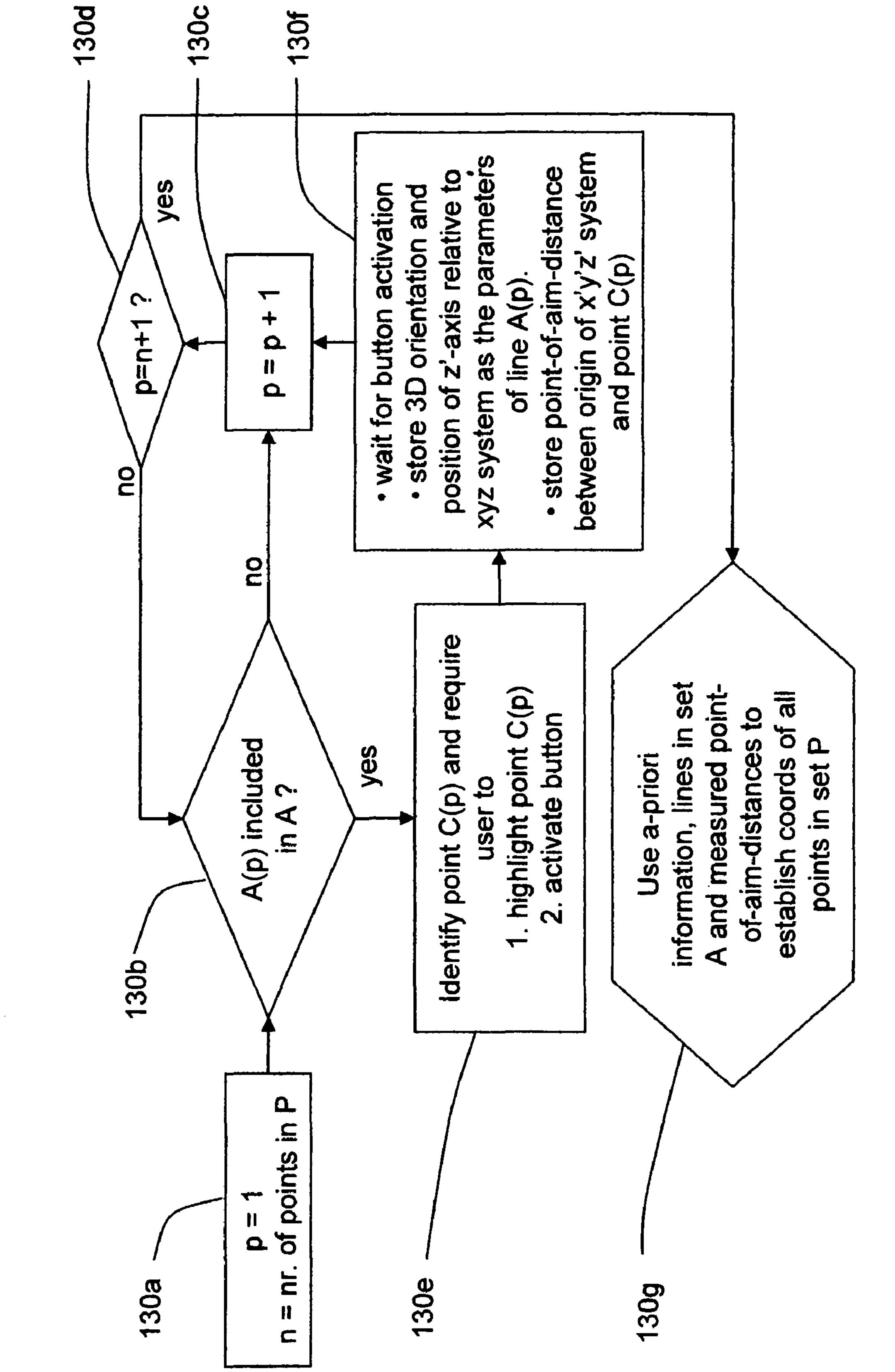
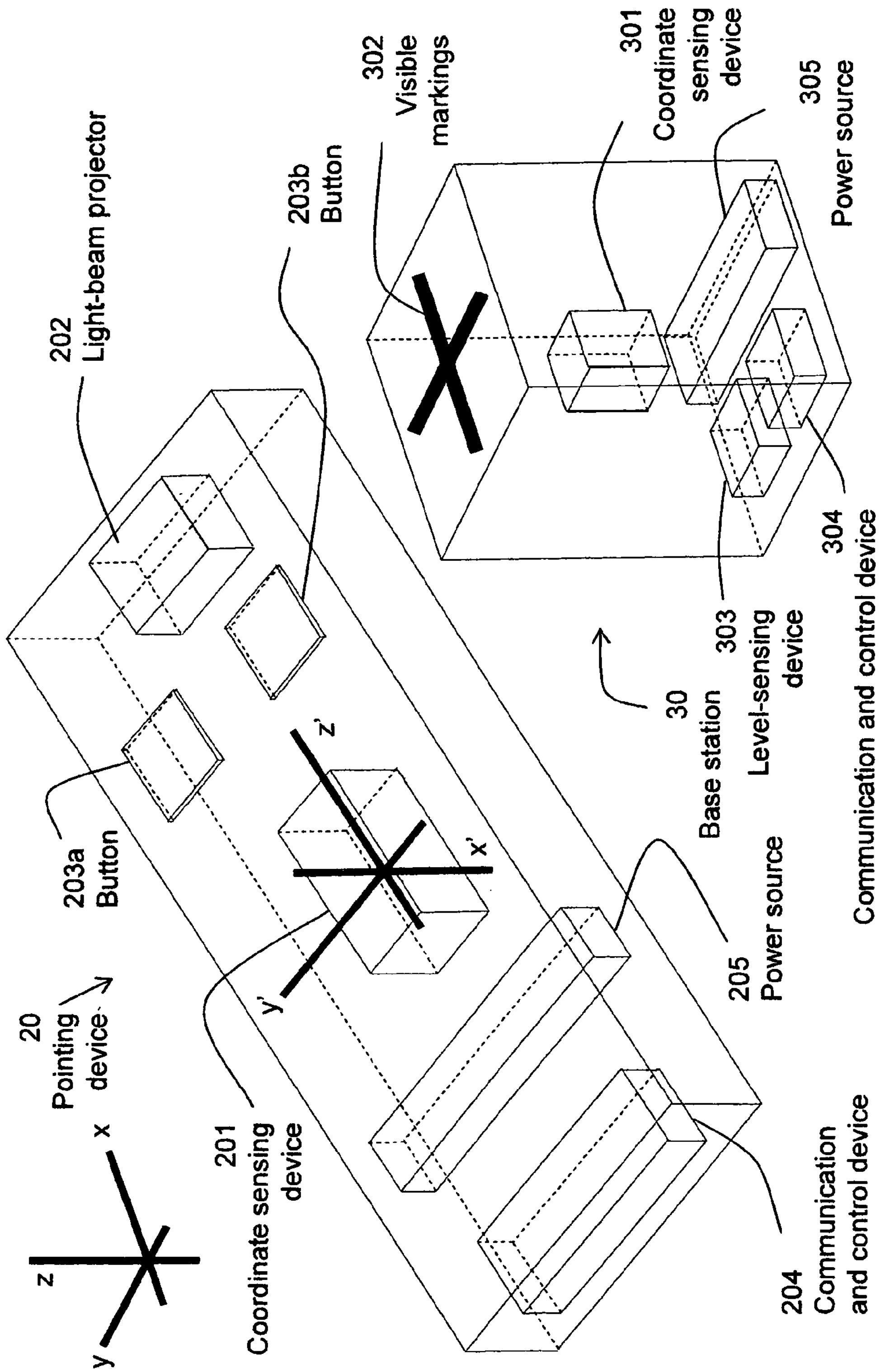

130a
p = 1
n = nr. of points in P
130b
A(p) included in A ?
yes
no
130c
p = p + 1
130d
p=n+1 ?
yes
no
130e
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
130f
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p).
• store point-of-aim-distance between origin of x'y'z' system and point C(p)
130g
Use a-priori information, lines in set A and measured point-of-aim-distances to establish coords of all points in set P

Fig. 12



202
Light-beam projector
203b
Button
302
Visible
markings
301
Coordinate
sensing
device
305
Power source
203a
Button
z'
x'
y'
20
Pointing
device
x
z
y
201
Coordinate sensing
device
205
Power source
30
Base station
303
Level-sensing
device
304
Communication and control device
204
Communication
and control device

Fig. 13

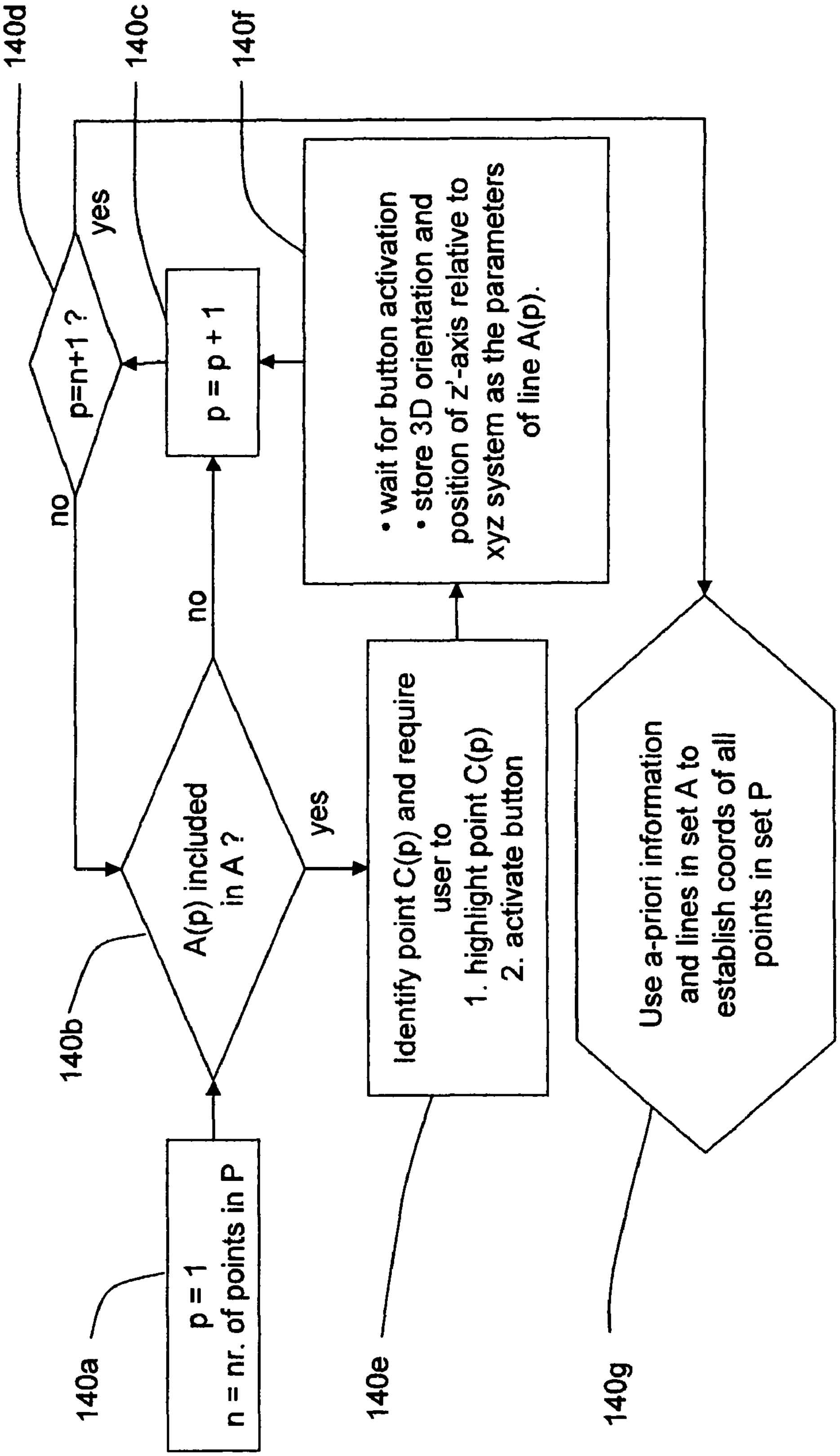

140a
p = 1
n = nr. of points in P
140b
A(p) included in A ?
no
yes
140c
p = p + 1
140d
p=n+1 ?
no
yes
140e
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
140f
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p).
140g
Use a-priori information and lines in set A to establish coords of all points in set P

Fig. 14

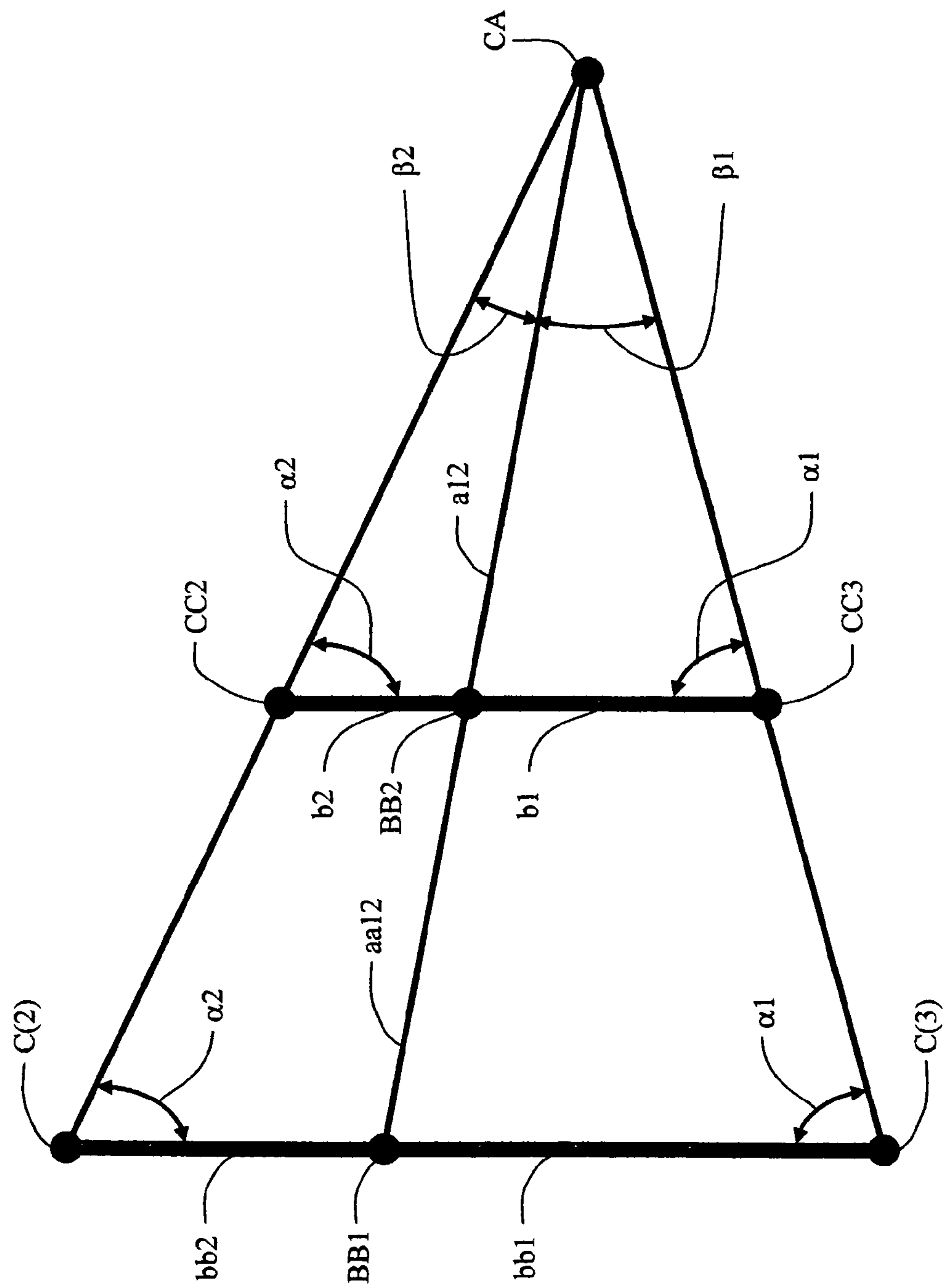


Fig. 15

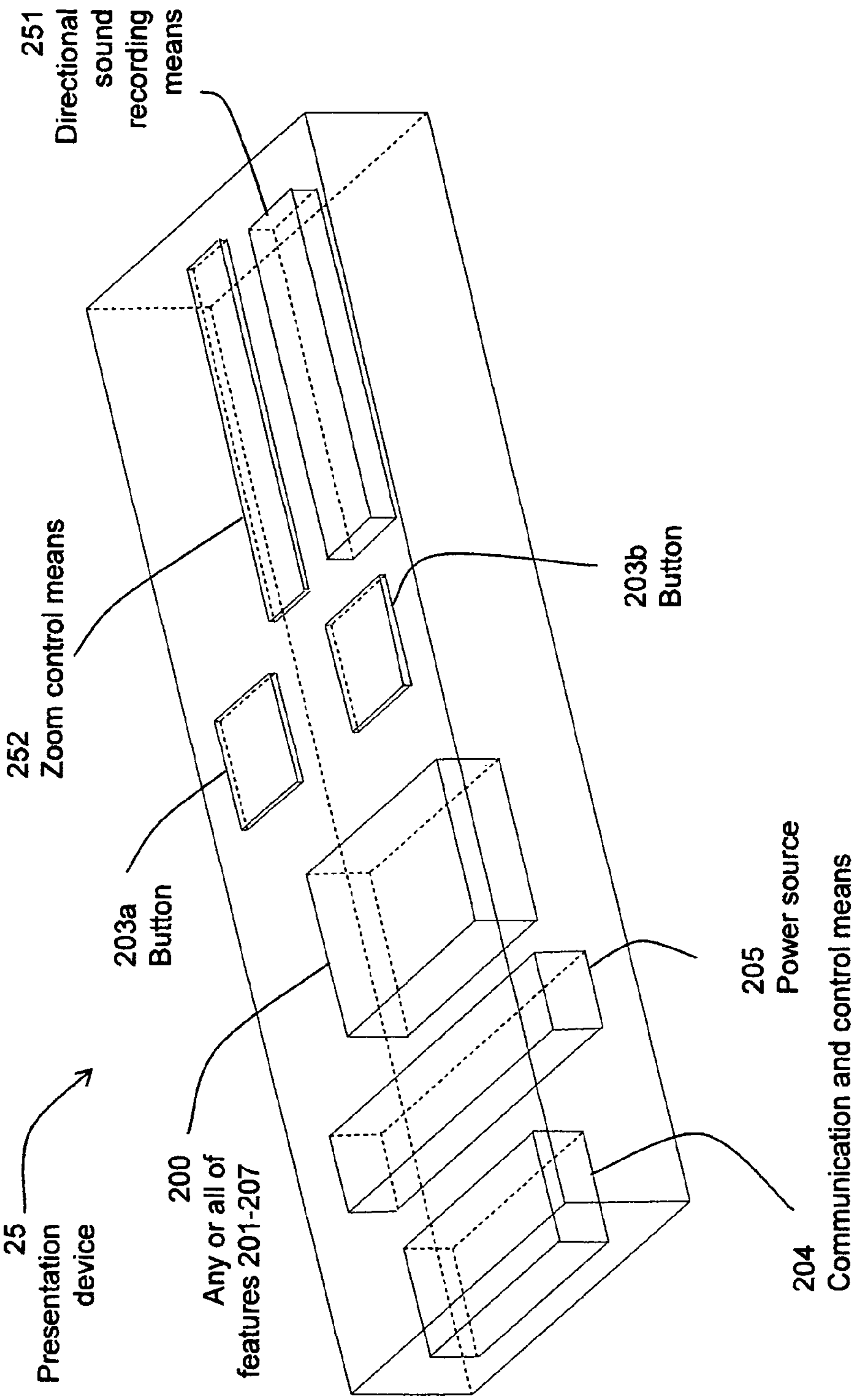
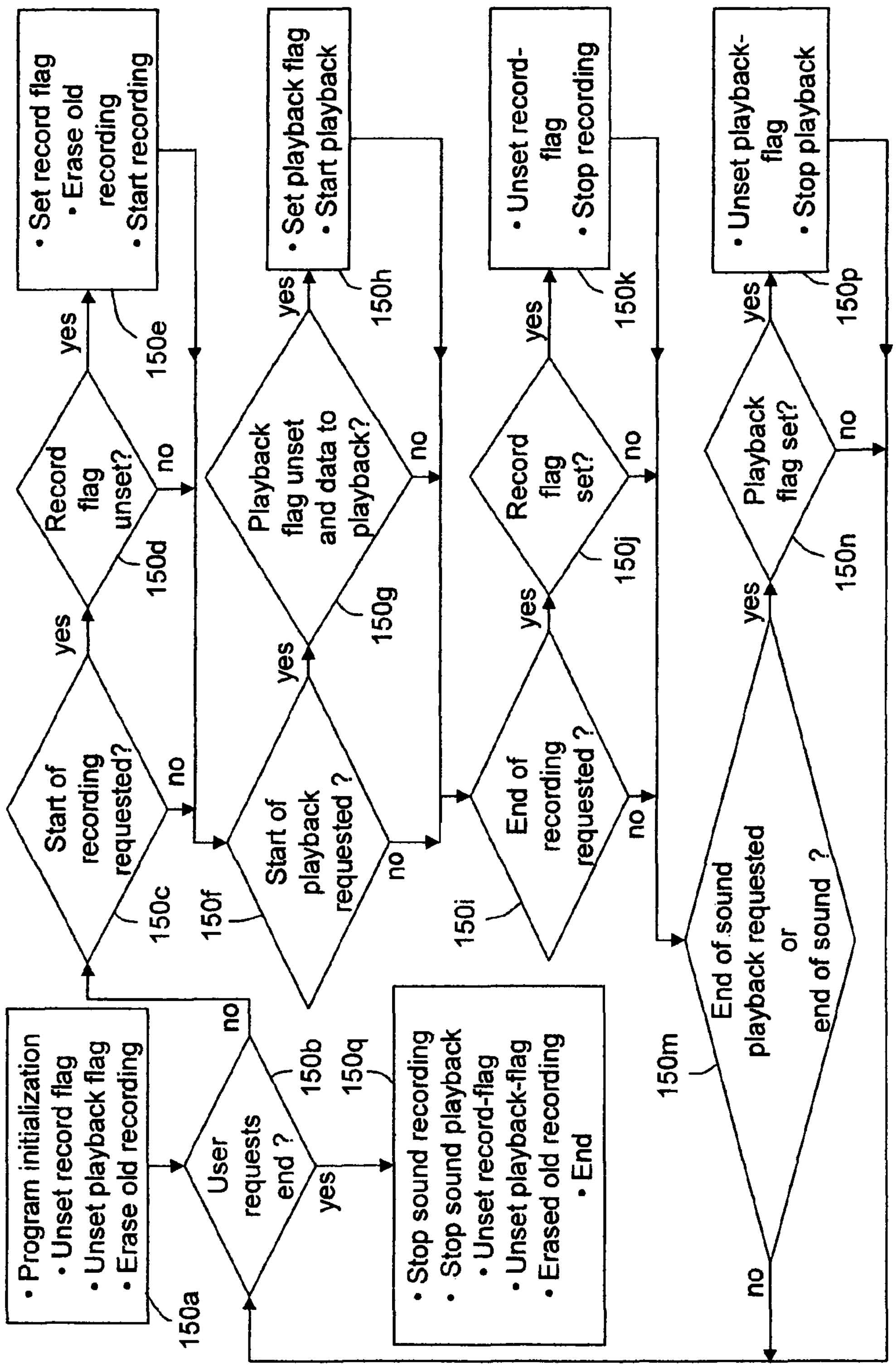

251
Directional
sound
recording
means
252
Zoom control means
203b
Button
203a
Button
25
Presentation
device
200
Any or all of
features 201-207
205
Power source
204
Communication and control means

Fig. 16



• Program initialization
• Unset record flag
• Unset playback flag
• Erase old recording
150a
User requests end ?
150b
yes
no
• Stop sound recording
• Stop sound playback
• Unset record-flag
• Unset playback-flag
• Erased old recording
• End
150q
Start of recording requested?
150c
yes
no
Record flag unset?
150d
yes
no
• Set record flag
• Erase old recording
• Start recording
150e
Start of playback requested ?
150f
yes
no
Playback flag unset and data to playback?
150g
yes
no
• Set playback flag
• Start playback
150h
End of recording requested ?
150i
yes
no
Record flag set?
150j
yes
no
• Unset record-flag
• Stop recording
150k
End of sound playback requested or end of sound ?
150m
yes
no
Playback flag set?
150n
yes
no
• Unset playback-flag
• Stop playback
150p

Fig. 17

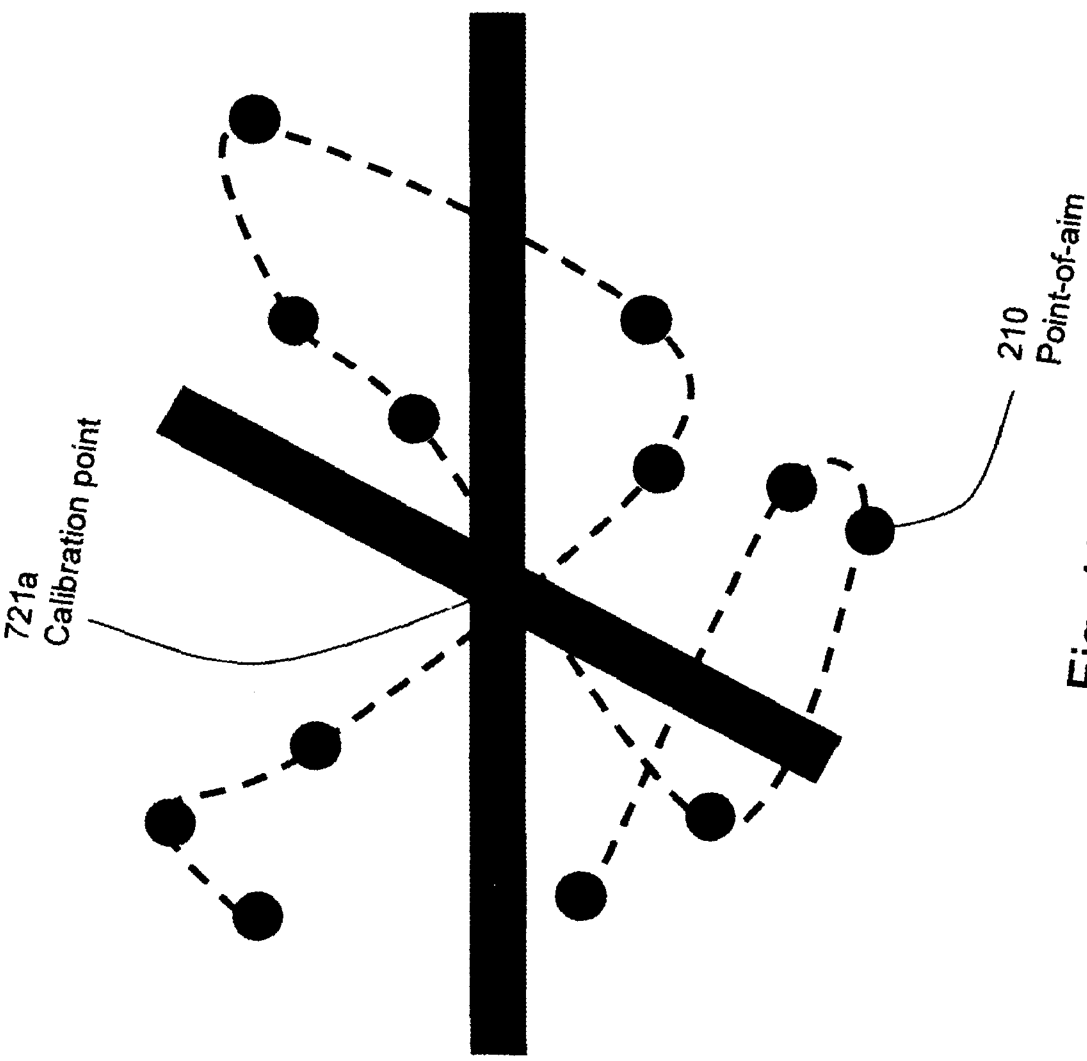
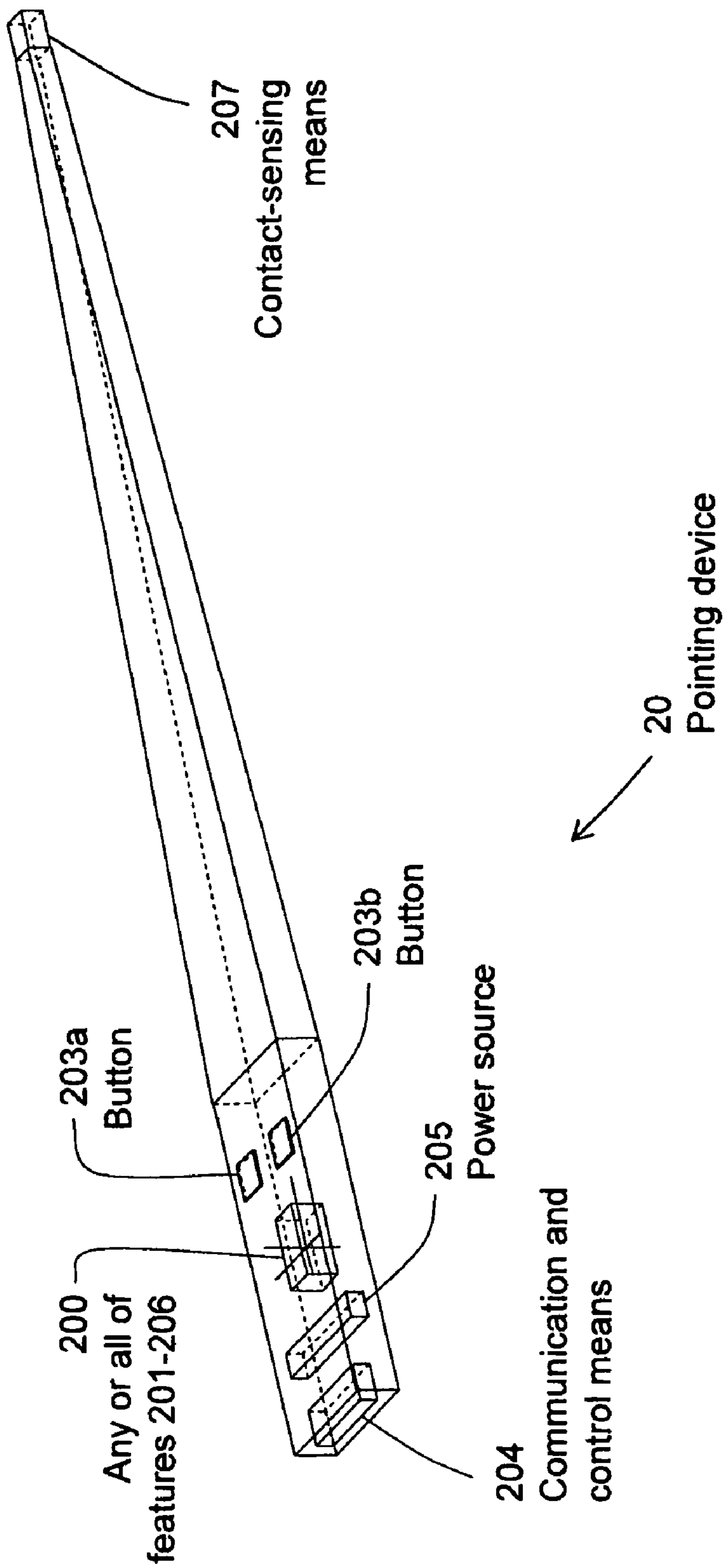


Fig. 18



207
Contact-sensing means
20
Pointing device
203a
Button
203b
Button
205
Power source
200
Any or all of features 201-206
204
Communication and control means

Fig. 19

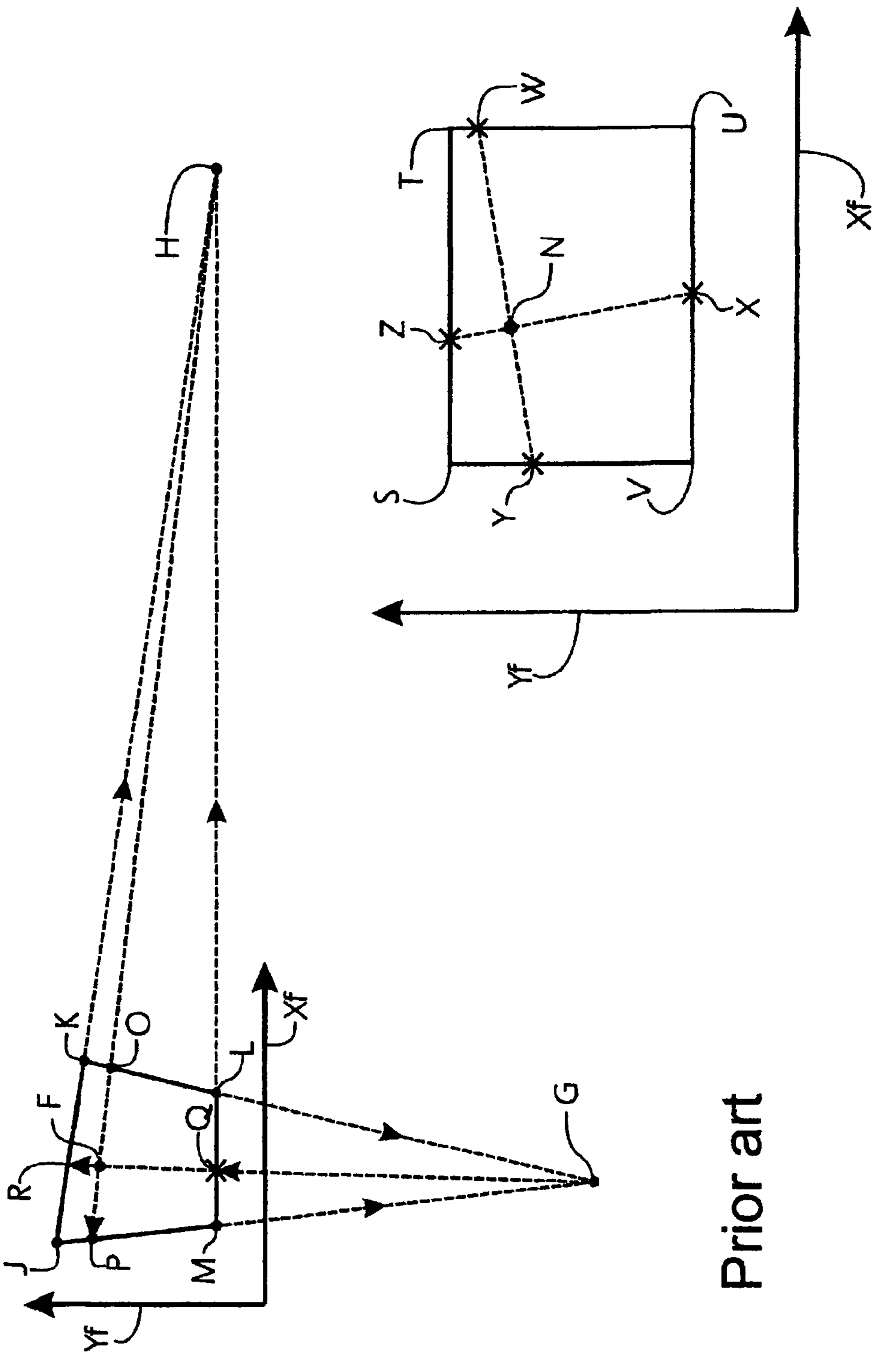


Fig. 20

EASILY DEPLOYABLE INTERACTIVE DIRECT-POINTING SYSTEM AND PRESENTATION CONTROL SYSTEM AND CALIBRATION METHOD THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

Priority is claimed from U.S. Provisional Application No. 60/575,671 filed on May 28, 2004 and from U.S. Provisional Application No. 60/644,649 filed on Jan. 18, 2005.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to devices for making presentations in front of audiences and, more specifically, to devices and methods for making presentations for which interaction with the displayed information through direct-pointing is desired or for which verbal interaction with the audience may be anticipated.

2. Background Art

Technology for presenting computer-generated images on large screens has developed to the point where such presentations are commonplace. For example, the software package POWERPOINT, sold by Microsoft Corp., Redmond, Wash., may be used in combination with a so-called 'beamer' to generate interactive presentation material and project for viewing by an audience. Often, such presentations are held in rooms not specifically equipped for the purpose of showing presentations, in which case use is made of a portable beamer in combination with a so-called 'laptop' computer. Under these circumstances the projection surface may be a wall of the room.

During a presentation it is desirable for the presenter to be able to move freely in front of the audience while retaining the capability to interact with the presentation and point to specific features on the displayed images. It would also be desirable for the presenter to be able to capture verbal comments made by members of the audience so as to amplify and/or play them back to the larger audience.

In general, interaction with a computer is often facilitated by pointing devices such as a 'mouse' or a 'trackball' that enable manipulation of a so-called 'cursor'. Traditionally, these devices were physically connected to the computer, thus constraining the freedom-of-movement of the user. More recently, however, this constraint has been removed by the introduction of wireless pointing devices such as the GYROMOUSE, as manufactured by Gyration, Inc.

Broadly speaking, pointing devices may be classified in two categories: a) devices for so-called 'direct-pointing' and b) devices for so-called 'indirect-pointing'. Direct pointing devices are those for which the physical point-of-aim coincides with the item being pointed at, i.e., it lies on the line-of-sight. Direct pointing devices include the so-called 'laser pointer' and the human pointing finger. Indirect pointing devices include systems where the object of pointing (e.g., a cursor) bears an indirect relationship to the physical point-of-aim of the pointing device; examples include a mouse and a trackball. It needs no argument that direct-pointing systems are more natural to humans, allowing faster and more accurate pointing actions.

Indirect pointing devices known in the art include the following. U.S. Pat. No. 4,654,648 to Herrington et al. (1987), U.S. Pat. No. 5,339,095 to Redford (1994), U.S. Pat. No. 5,359,348 to Pilcher et al. (1994), U.S. Pat. No. 5,469,193 to Giobbi et al. (1995), U.S. Pat. No. 5,506,605 to Paley (1996), U.S. Pat. No. 5,638,092 to Eng et al. (1997), U.S. Pat. No. 5,734,371 to Kaplan (1998), U.S. Pat. No. 5,883,616 to Koizumi et al. (1999), U.S. Pat. No. 5,898,421 to Quinn (1999), U.S. Pat. No. 5,963,134 to Bowers et al. (1999), U.S. Pat. No. 5,999,167 to Marsh et al. (1999), U.S. Pat. No. 6,069,594 to Barnes et al. (2000), U.S. Pat. No. 6,130,664 to Suzuki (2000), U.S. Pat. No. 6,271,831 to Escobosa et al. (2001), U.S. Pat. No. 6,342,878 to Chevassus et al. (2002), U.S. Pat. No. 6,388,656 to Chae (2002), U.S. Pat. No. 6,411,277 to Shah-Nazaroff (2002), U.S. Pat. No. 6,492,981 Stork et al. (2002), U.S. Pat. No. 6,504,526 to Mauritz (2003), U.S. Pat. No. 6,545,664 to Kim (2003), U.S. Pat. No. 6,567,071 to Curran et al. (2003) and U.S. Patent Application Publication No. 2002/0085097 to Colmenarez et al. (2002). Each of the foregoing publications discloses a system for which the 2 dimensional or 3 dimensional position, orientation and/or motion of an object, such as a handheld pointing device, are measured with respect to some reference coordinate system using appropriate means. Such means include acoustic devices, electromagnetic devices, infrared devices, visible light emitting diode (LED) devices, charge coupled devices (CCD), accelerometer and gyroscopic motion detectors, etc. Although for some of the foregoing devices the reference coordinate system may be positioned close to the display means, no information on the actual position of the presentation display with respect to the system is used, causing the resulting pointing action to be inherently indirect and, hence, less natural to the human operators of such systems.

Other inherently indirect-pointing systems that do not require the position or orientation of the pointing device to be known include devices such as disclosed in U.S. Pat. No. 5,095,302 to McLean et al. (1992) and U.S. Pat. No. 5,668,574 to Jarlance-Huang (1997). The foregoing patents describe indirect-pointing methods, that do not provide the speed and intuitiveness afforded by direct-pointing systems.

Direct pointing devices are disclosed, for example, in U.S. Pat. No. 4,823,170 to Hansen (1989), which describes a direct-pointing system comprising a light source, a position-sensing detector located adjacent to the light source and a focusing reflector that, in one application, is parabolic shaped and is attached to the pointing device. Additionally, procedures are described to calibrate the system. In the understanding of current applicant, however, the physical location of the position-sensing detector needs to be, at least preferably, adjacent to the display means. The system disclosed in the Hansel '170 patent cannot easily be ported to a room not specifically equipped for this system.

U.S. Pat. No. 5,929,444 to Leichner (1999) discloses a system primarily intended for target shooting practice, but an application as a direct-pointing cursor control apparatus may arguably be anticipated. The system includes transmitting and detecting equipment in a fixed reference base and a moveable pointing device. A calibration routine is described that aligns the detecting and transmitting means while keeping the pointing device (i.e., a gun) aimed at the center of the target. The Leichner '444 patent does not describe methods or means that allow determination of a point-of-aim of a pointing device on a target of which the size and/or orientation have not been predetermined. Consequently, the system disclosed in the Leichner '444 patent is not suitable to be used as a cursor control means for projection surfaces not specifically adapted to be used with such system.

U.S. Pat. No. 5,952,996 to Kim et al. (1999), U.S. Pat. No. 6,184,863 to Sibert et al. (2001) and US Patent Application Publication No. 2002/0084980 to White et al. (2002) disclose direct-pointing systems where the 3 dimensional position and/or orientation of the pointing device is measured with respect to sources and/or detectors, the physical position of which in relation to the display means is presumed known. Such systems only work in rooms specifically equipped for their use.

U.S. Pat. No. 5,484,966 to Segen (1996) , U.S. Pat. No. 6,335,723 to Wood et al. (2002) and U.S. Pat. No. 6,507,339 to Tanaka (2003) disclose methods suitable for direct-pointing that are useful only if the pointing device is physically close to or touching the display area or volume, for example used with so-called 'interactive whiteboards'. Some of the foregoing patents describe appropriate pointer calibration routines. Such systems are not suitable for presentations where the display surface is out of the presenter's physical reach.

U.S. Pat. No. 6,104,380 to Stork et al. (2000) discloses a direct-pointing system in which at least the 3 dimensional orientation of a handheld pointing device is measured by appropriate means. Additionally, a direct measurement is made of the distance between the pointing device and the displayed image. However, the system disclosed in the Stork et al. '380 patent does not include methods to ascertain the position and orientation of the display means relative to the pointing device. In the foregoing system, these appear to be presumed known. This is also the case for a system disclosed in U.S. Pat. No. 4,768,028 to Blackie (1988), in which the orientation of a helmet-mounted direct-pointing apparatus is measured electromagnetically. The foregoing systems therefore appear to be ill-suited to operate in rooms not specifically equipped for presentation purposes.

U.S. Pat. No. 6,373,961 to Richardson et al. (2002) discloses a direct-pointing system using helmet-mounted eye tracking means. The point-of-gaze relative to the helmet is measured as well as the position and orientation of the helmet relative to the display. The latter is accomplished by equipping the helmet either with means to image sources mounted at fixed positions around the display or with means to image a displayed calibration pattern. Of course, the foregoing system relies on sophisticated helmet mounted equipment capable of, among other things, tracking eye-movement. Moreover, such a system relies on an unobstructed line-of-sight with respect to the display and a substantially constant distance from the display to the helmet-mounted equipment. The disclosed invention does not lend itself to be easily used by a human operator in an arbitrary (not predetermined) presentation setting.

U.S. Pat. No. 6,385,331 to Harakawa et al. (2002) discloses a system that uses infrared technology in combination with image recognition software to distinguish pointing gestures made by the presenter, without the need for an artificial pointing device. The disclosed system, however, requires the presentation room to be set up with highly tuned and sophisticated equipment, and is therefore not easily ported to a different venue.

U.S. Pat. No. 6,404,416 to Kahn et al. (2002) discloses a direct-pointing system where a handheld pointing device is equipped with an optical sensor. In such system either the display is required to be of a specific type (e.g., a cathode ray-based display that uses an electron beam) or the displayed image is required to be enhanced by timed and specific emanations. When pointed to the display, a handheld pointing device may detect the electron beam or the timed emanations, and the timing of these detections may then be used to ascertain the point-of-aim. The disclosed system is somewhat similar to the technologies used for so-called light guns in video games as disclosed, for example, in U.S. Pat. No. 6,171,190 to Thanasack et al. (2001) and U.S. Pat. No. 6,545,661 to Goschy et al. (2003). Of course, such systems require either a specific display apparatus or a specialized modification of the displayed images. Moreover, an uncompromised line-of-sight between the pointer and the display is a prerequisite for such systems.

U.S. Patent Application Publication No. 2002/0089489 to Carpenter (2002) discloses a direct-pointing system that, in one embodiment, positions a computer cursor at a light spot projected by a laser-pointer. The system relies on the use of an image-capturing device to compare a captured image with a projected image. As such, the system disclosed in the '489 application publication makes use of calibration routines in which the user is required to highlight computer-generated calibration marks with the laser pointer. The system disclosed in the '489 patent application publication is not unlike a system disclosed in U.S. Pat. No. 5,502,459 to Marshall et al. (1996). Also, U.S. Pat. No. 5,654,741 to Sampsell et al. (1997), U.S. Pat. No. 6,292,171 to Fu et al. (2001), U.S. Patent Application Publication No. 2002/0042699 to Tanaka et al. (2002) and U.S. Patent Application Publication No. 2002/0075386 to Tanaka (2002) all disclose systems that can detect a light-spot using optical means. Such systems specifically generally require the use of computationally expensive image processing technologies. All of these inventions require a projection surface with adequate diffusion properties, as well as some form of optical system with a steady and uncompromised view of the display area. As such, they limit the freedom-of-movement of the presenter and place limitations on the position and optical characteristics of the necessary equipment. Also, in some of these inventions fast and involuntary movement of the user's hand may result in a cursor that does not move smoothly or a cursor that does not perfectly track the light spot, causing possible confusion with the user.

Other pointing systems known in the art may be classified as other than entirely direct-pointing or indirect-pointing systems. Such systems include one disclosed in U.S. Pat. No. 6,417,840 to Daniels (2002), which is combination of a cordless mouse with a laser pointer. Although this system incorporates a direct-pointing device (i.e., the laser pointer), the method used by the system for interacting with the presentation is indirect (i.e., by means of the mouse) and therefore does not afford the fast and more accurate interactive pointing actions provided by some other direct-pointing systems described in some of the foregoing publications.

Another system known in the art that uses both direct and indirect-pointing methods is described in U.S. Pat. No. 6,297,804 to Kashitani (2001). The disclosed system is a system for pointing to real and virtual objects using the same pointing device. In the disclosed system, the pointing means switch between a computer controlled light source (e.g., a laser) and a conventional computer cursor, depending on whether or not the user's intended point-of-aim has crossed a boundary between the real and virtual display (i.e., computer-displayed imagery). Various methods are described to establish these boundaries. Although the computer-controlled light source may be regarded as pointing in a direct manner, its point-of-aim is essentially governed by the system operator using an indirect-pointing system such as a mouse. Thus, the disclosed system does not allow for the desired flexibility afforded by truly direct-pointing methods.

Other systems known in the art include those such as disclosed in U.S. Pat. No. 5,796,386 to Lipscomb et al. (1998),

which discloses a calibration procedure to establish the relation between coordinate systems associated with a handheld device and, in one embodiment, a display unit. The system disclosed in the Lipscomb et al. '386 patent may arguably be applicable as a direct-pointing cursor control system. The disclosed calibration routine requires the user to register at least three 3 dimensional positions of the handheld device with a central processing unit. The disclosed system does not appear to include calibration methods for the case where the display unit is out of physical reach of the system operator. The system is thus not practical for use at an arbitrary venue.

U.S. Pat. No. 6,084,556 to Zwern (2000) discloses a head-mounted display unit that displays information governed by the orientation of the apparatus, as measured by a tracking device. This way, the system creates the illusion of a large virtual display that is being looked at by the system operator. Of course, the large display alluded to does not constitute a projected presentation. Also, no methods are disclosed in the Zwern '556 patent to establish the relative position of the head-mounted apparatus with respect to the display.

U.S. Patent Application Publication No. 2002/0079143 to Silverstein et al. (2002) discloses a system in which the position of a moveable display with respect to a physical document is established. The '143 patent application publication describes calibration routines in which the user is required to activate a registration button when the moveable display is over some predetermined position on the physical document. The disclosed system only relates to 2 dimensional applications and, moreover, cannot be used in situations where the interaction region is out of the system operator's physical reach.

U.S. Pat. No. 5,339,095 to Redford (1994) discloses an indirect-pointing system where the pointing device is equipped with non-directional microphone. Also, U.S. Pat. No. 5,631,669 to Stobbs et al. (1997) discloses the inclusion of a non-directional microphone unit in an indirect-pointing device.

SUMMARY OF THE INVENTION

One aspect of the invention is a method for controlling a parameter related to a position of a computer display cursor based on a point-of-aim of a pointing device within an interaction region. The method includes projecting an image of a computer display to create the interaction region. At least one calibration point having a predetermined relation to the interaction region is established. A pointing line is directed to substantially pass through the calibration point while measuring a position of and an orientation of the pointing device. The pointing line has a predetermined relationship to said pointing device. The parameter related to the position of the cursor within the interaction region is controlled using measurements of the position of and the orientation of the pointing device.

Another aspect of the invention is a method for controlling a computer display cursor in an interaction region. According to this aspect, the method includes establishing a calibration point having a predetermined relation to the interaction region. At least one of a position and orientation of a pointing line is first measured while directing the pointing line to substantially pass through the calibration point. The first measurement is used to constrain a parameter of the calibration point. The pointing line has a predetermined relationship to at least one of position and orientation of a pointing device. A characteristic feature of the interaction region is used to establish a property of a common point of the pointing line and the interaction region measured relative to the interaction region. At least one of position and orientation of the pointing device is measured, and the characteristic feature of the interaction region and measurement of the pointing device are used to control the cursor on a computer display image.

Another aspect of the invention is a method for controlling a parameter related to position of a cursor on a computer screen image. The method according to this aspect includes measuring a first angle between a pointing line and a first line, and measuring a second angle between the pointing line and a second line. The first line is related in a predetermined way to a geographic reference, and the second line is related in a predetermined way to a geographic reference. The pointing line has a predetermined relation to said pointing device. A first parameter related to the first angle, and a second parameter related to the second angle are used to control the parameter of the cursor on said computer screen image, whereby the cursor position parameter is controlled by movement of the pointing device.

Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a pointing device and base station according to a first embodiment.

FIG. **2** shows a presentation venue and computer screen.

FIG. **3** shows program steps for selection of appropriate assumptions according to embodiments 1, 2 and 3.

FIG. **4** shows program steps for construction of information set according to a first embodiment.

FIG. **5** shows program steps for ascertaining necessary 3D data according to a first embodiment.

FIG. **6** shows program steps for control of pointing device elements and computer cursor according to several embodiments.

FIG. **7** shows one example of a first embodiment.

FIG. **8** shows a second example of one embodiment of the invention.

FIG. **9** shows a third example of one embodiment.

FIG. **10** shows a pointing device and base station according to a second embodiment.

FIG. **11** shows program steps for construction of information set according to a second and third embodiment.

FIG. **12** shows program steps for ascertaining necessary 3D data according to the second embodiment.

FIG. **13** shows a pointing device and base station according to a third embodiment

FIG. **14** shows program steps for ascertaining necessary 3D data according to the third embodiment.

FIG. **15** shows projection of interaction structure on horizontal and vertical planes.

FIG. **16** shows a presentation device according to a fourth embodiment.

FIG. **17** shows program steps for sound recording and playback according to the fourth embodiment.

FIG. **18** shows an image of calibration point and light spots at the points-of-aim.

FIG. **19** shows an alternative embodiment of pointing device.

FIG. **20** shows a prior art: construction of method M for a quadrangle.

DETAILED DESCRIPTION

A first embodiment of the invention will be described with reference to FIG. **1**. A pointing device **20** has associated with

it a coordinate system x' y' z'. A portable base station **30** has associated with it a coordinate system x y z. Pointing device **20** and base station **30** may be equipped with coordinate sensing devices, **201** and **301**, respectively, that enable measurement of the 3 dimensional position and 3 dimensional orientation of pointing device **20** and, therefore, of a pointing line **21** (see also FIG. **2**) that substantially intersects pointing device **20**, all measured relative to the x y z coordinate system. Pointing line **21** may substantially coincide with the long axis of pointing device **20**. For example, coordinate sensing devices **201** and **301** may be electromagnetic tracking devices, such as the 3SPACE FASTRAK® system, manufactured by Polhemus, a Kaiser Aerospace & Electronics Company, Colchester, Vt. Alternatively, coordinate sensing device **201** and **301** may be based on ultrasonic tracking systems such as those used in the LOGITECH 2D/6D computer mouse, commercially available from Logitech Inc., Fremont, Calif. Other embodiments for coordinate sensing device **201** and **301** may include, without limitation, sensors based on LEDs, CCDs, accelerometers, inclinometers, gyroscopes, compasses, magnetometers, etc. Also, combinations of such different types of sensors may be used to acquire redundant measurements for quality control purposes. For example, a controlled-source electromagnetic position tracking system may be combined with compasses and inclinometers. Those skilled in the art will appreciate that independent measurements of the Earth's magnetic field and gravity may be used to enhance the measurements made by a controlled-source position detecting system. In the invention, any system may be used that is capable of determining at least parts of the orientation and position in three dimensions, with respect to coordinate system x y z, of a line-segment that substantially intersects pointing device **20**.

Base station **30** may comprise a plurality of related physical entities, such as described in U.S. Pat. No. 6,608,668 to Faul et al. (2003); for clarity of explanation one of these physical entities will be associated with coordinate system x y z and be denoted as base station **30**, the center of which substantially coincides with the origin of coordinate system x y z. For purposes of explanation of the invention, the origin of coordinate system x' y' z' substantially coincides with the center of pointing device **20**, and the z'-axis is substantially aligned with the long axis of pointing device **20**.

Pointing device **20** may also be provided with a light-beam projector **202**, for example a laser. The physical position and orientation of the projected beam of light with respect to coordinate system x' y' z' may be established with suitable accuracy at the place of manufacture of the pointing device **20** and may be presumed to be known. For purposes of explanation, the beam of light from the light beam projector **202** substantially coincides with the z'-axis. Additionally, one or more control buttons **203***a*, **203***b* or the like may be provided, as well as communication and control device **204**. Communication and control device **204** may be used to control various features of pointing device **20** and may also communicate via wire, or wirelessly, with base station **30** and/or a central processing unit (not shown separately), such as a COMPAQ Armada M700 as manufactured by Hewlett Packard Company, Palo Alto, Calif. The central processing unit may also control a presentation with which user interaction is desired. For clarity of the description which follows, the central processing unit will be referred to hereinafter as "the computer." Furthermore, pointing device **20** may include an internal power source **205**, for example a battery, or instead may be connected such as by wire to an external power source.

In addition to coordinate sensing device **301**, base station **30** may be provided with communication and control device

304. Communication and control device **304** may be used to control various features of base station **30**. Communication and control device **304** may communicate with pointing device **20** and/or with the computer (not shown) that may control the presentation images. The communication and control device **304** may use wire- or wireless technology. In the present embodiment communication with the computer occurs via a universal serial bus (USB) compatible device or the like (not shown). Communication and control device **304** may communicate wirelessly with a relay device (not shown) that communicates via a USB compatible device or the like with the computer (not shown) that may control the presentation with which user-interaction is desired. There may be visible markings **302** on base station **30** that indicate the orientation of one or more coordinate planes defined by prescribed relations between coordinates x, y, z, as well as features of the position of the origin of the x y z coordinate system. For example, a line may be used to indicate the z-x-plane of the x y z coordinate system, for which the y-coordinate is zero; another line may be used to indicate the z-y-plane, for which the x-coordinate is zero. Base station **30** may be provided with a level-sensing device **303** to determine whether or not one of the coordinate planes of coordinate system x y z is substantially horizontal. Level-sensing device **303** may measure two angles or equivalent characteristics that define the orientation of one of the coordinate planes of coordinate system x y z with respect to a horizontal surface. Level-sensing device **303** can be a device such as disclosed in U.S. Pat. No. 6,466,198 to Feinstein (2002), which makes use of model ADXL202 accelerometers sold by Analog Devices Inc., Norwood, Mass. The disclosed accelerometers provide tilt angle information depending on their inclination relative to Earth's gravity. It will be apparent to those skilled in the art that many other types of sensors may be used as embodiment for level-sensing device **303**, for example, capacitance-type bubble levels. See, for example, U.S. Pat. No. 5,606,124 to Doyle et al. Finally, base station **30** may be equipped with a power source **305**, for example a battery, or may have a connection to an external power source.

Referring to FIG. **2**, a projection device **40** is arranged to project an image **50** generated by, for example, the computer (not shown). The projection device **40** may be used to generate a projection image **70** on a projection region **60**. For example, projection device **40** may be a 2000 lumen projector, model XL8U, manufactured by Mitsubishi Corp. Projection region **60** may be a surface, such as a wall or a projection screen. The projection region **60** may define a flat plane or a may define a more elaborate 2 dimensional (2D) or even 3 dimensional (3D) structure. In FIG. **2**, projection region **60** is shown as a screen, but this is only for purpose of illustrating the principle of the invention and is not intended to limit the scope of the invention. Alternatively the combination of projection device **40** and projection region **60** may be incorporated in one and the same physical device, such as a television receiver (cathode ray tube display), liquid crystal display (LCD) screen or the like.

There is a region of space that is designated as a region on which interaction with the user is desired. This region is denoted as the interaction region **71**. The interaction region **71** may be flat (planar) or may be a more elaborate 2D or even 3D structure. The interaction region **71** may have features in common with projection image **70** and may be associated in some way with a computer screen interaction region **51**. In the present embodiment, however, it will be assumed that interaction region **71** or a scaled version thereof, is substantially part of or substantially coincides with projection image **70**. Moreover, it will be assumed in this embodiment that inter-

action region **71** substantially coincides with the projection of computer screen interaction region **51** as projected by projection device **40**.

For display systems which include a separate projection device **40** and projection region **60**, the optical axis of projection device **40** may not be aligned with any vector normal to projection region **60**. Moreover, projection region **60** may not be flat and therefore may not even be a 2D shape. Consequently, projection image **70** and interaction region **71** may in general not be flat or rectangular, even if the imagery generated by the computer is scaled so as to be presented in rectangular form. In this embodiment, however, it is assumed that projection region **60**, projection image **70** and interaction region **71** are substantially flat. Furthermore, it is assumed in this embodiment that interaction region **71** is substantially a quadrangle and that the associated computer screen interaction region **51** is substantially rectangular.

Additionally, calibration points **721**_a_, **721**_b_, **721**_c_, **721**_d_ may be provided that may define characteristic features of interaction region **71**. For example, interaction region **71** may be trapezoidal in shape, in which case calibration points **721**_a_, **721**_b_, **721**_c_, **721**_d_ may define corners of interaction region **71** or corners of a scaled version thereof. Furthermore, screen marks **521**_a_, **521**_b_, **521**_c_, **521**_d_ may be provided, and may but need not be associated with calibration points **721**_a_-**721**_d_ For example, calibration points **721**_a_-**721**_d_ may coincide with the projected versions of screen marks **521**_a_-**521**_d_ and may in this way be identified by projection device **40**. Calibration points **721**_a_-**721**_d_ may also be identified by other means than projection, for example by unique descriptions such as the 'upper right corner of interaction region **71**', 'center of interaction region **71**' etc.

The operation of the present embodiment will now be described with reference to FIGS. **1**, **2** and **3**. A display system is set up at the venue where a presentation is to made, which can be a combination of a portable projection device **40** and projection surface **60**, for example a wall. The display system is connected, using appropriate interconnection devices, to the computer (which may be in the base station **30** or located elsewhere) that generates the presentation images.

The system user positions base station **30** at a convenient location, preferably not far from where the user intends to make the presentation display. The user may position base station **30** in such a way that one of the coordinate planes of the x y z coordinate system is substantially parallel or substantially coincident with projection region **60**. The visual markings **302** may assist in such positioning. Subsequently, the user connects base station **30** to the computer (not shown), for example via a USB compatible device connection (not shown), or using a wireless relay device (not shown). The computer may be disposed in the base station **30** in some embodiments. In some embodiments, the computer may recognize the base station connection and start a program, part of which may be contained in the communication and control device **304**, in communication and control device **204**, or in control logic contained in the wireless relay device (not shown). Alternatively, the user may be required to load the program into the computer manually via a CD-ROM drive, a floppy drive, memory stick (USB mass storage device—not shown) or the like. However it is loaded into the computer, the program may initiate a calibration routine that has as its object establishment of the shape, position, size and orientation of a defined interaction structure **72** relative to the x y z coordinate system. The interaction structure **72** is assumed to substantially coincide with interaction region **71**. The operation of the program will now be explained with reference to FIG. **3**.

At **80**_a_ the program is initiated. During step **80**_b_ a default assumption is made regarding interaction region **71**. Specifically, interaction region **71** is assumed to substantially coincide with a well-defined interaction structure **72** (FIG. **2** shows an interaction region **71** and an interaction structure **72** that are clearly not identical; this difference is however only meant as an example, and as a practical matter is preferably as small as possible). At **80**_b_ default values are entered for the orientation and position of this interaction structure **72**. For example, the default setting may assume interaction region **71** to substantially coincide with an interaction structure **72** that is a (flat) quadrangle positioned in a vertical plane that substantially intersects the origin of the x y z coordinate system associated with base station **30**. As another example, the default setting may provide that interaction region **71** substantially coincides with an interaction structure **72** that is an isosceles trapezoid of which the parallel edges are horizontal and of which the position is unknown. Using such default values, calibration points **721**_a_-**721**_d_ not only define characteristic features of interaction region **71** but also of interaction structure **72**.

At **80**_c_ a decision is made whether the default values for interaction region **71** and interaction structure **72** should be accepted or overridden by the user. In making this decision, input from level-sensing device **303** and visible markings **302** on base station **30** may be used. If the defaults are to be accepted, the program continues to **80**_j_, the details of which are explained below with reference to FIG. **4**. If the defaults are overridden, the program continues at **80**_d_ to **80**_i_, during each of which the user may override any of the default settings. The user may be aided during any of **80**_d_ to **80**_i_ by a library of predetermined shapes, predetermined orientations and/or predetermined positions, or the user can be provided by the program with the capability to construct custom shapes, orientations and/or positions. In any case, the program continues to **80**_j_.

It will be appreciated by those skilled in the art that once an assumption has been made regarding the shape of interaction structure **72**, it is possible to construct a set of three dimensionally distributed points in space that completely determines the 3D position, orientation and size of the interaction structure **72**. The number of points in the set will depend on the complexity of the assumed shape and the ingenuity with which the points are chosen. For example, a rectangular shape that is arbitrarily oriented in space is completely determined by a set of 3 points that coincide with 3 of its corners, but is also completely determined by a set of 8 points, pairs of which may determine each of the four edges of the rectangle.

Referring to FIG. **4**, describing details of program element **80**_j_, the computer program continues at **90**_a_, at which a set P is generated that includes a quantity n of points in space, each represented as C(i) $(0<i<n+1)$, that uniquely determine interaction structure **72**, together with descriptions of their roles in determining this structure. For example, if the program elements outlined in FIG. **3** reveal that interaction region **71** is assumed rectangular, set P may hold three points described as the upper-left corner, the lower-left corner and the upper-right corner of a rectangular interaction structure **72**. If, alternatively, the projection of computer screen interaction region **51** is substantially rectangular, and this projected rectangle has the same center but is physically two times smaller than interaction structure **72**, the three points may be described as the upper-right corner, the lower-left corner and the lower-right corner of a rectangle that has the same center but is two times smaller than interaction structure **72**. Thus, by carefully choosing the points in set P together with their description, any interaction structure **72** may be completely determined.

In addition to set P, a 3D point CA and another 3D point CB are determined at **90***a*. These additional 3D points are determined so as to lie away from interaction region **71**, that is, they lie at some distance out of the plane that is closest to or substantially contains interaction region **71**. The distance may be comparable to an edge of projection image **70**. For example, point CA may be determined to lie near projection device **40** and point CB may be determined to lie at a distance from point CA that may be equal to the distance between projection device **40** and projection surface **60**, measured substantially parallel to projection surface **60**. Other choices for point CA and point CB may also be used. Additionally, sets A and B are generated during step **90***a*. Set A includes a number n of lines A(i), each of which connects point CA to one of the points C(i) (0<i<n+1) in set P. Likewise, set B holds a number n of lines B(i), each of which connects point CB to one of the points C(i) (0<i<n+1) in set P. Finally, at **90***a*, counters a, b are both initialized to the value of n.

Flow then continues on to step **90***b*, where a decision is made whether the program elements outlined in FIG. **3** have revealed any information on the 3D position and orientation of interaction structure **72**. If the decision is positive flow continues to step **90***c*, where this information is used to establish a priori relationships between the coordinates of the points in set P. For example, the steps outlined in FIG. **3** may have revealed that interaction structure **72** is assumed to coincide with the x-z plane, in which case the a priori relationships may include the requirement that the y-coordinates of all points in set P are equal to zero. A pre-set library of a priori relationships may be provided to aid in the execution of this program element.

The program continues to **90***d*, which may also be reached from **90***b* if the decision at **90***b* is negative. At **90***d*, line B(b) is removed from set B, after which counter b is decremented by 1.

The program continues to **90***e*, where a decision is made whether complete 3D information on the lines in sets A and B, together with a priori information, constitutes enough information to uniquely determine the coordinates of all the points in set P. For example, the program elements outlined in FIG. **3** may have determined that interaction region **71** is assumed to be rectangular, but no information is known regarding its orientation or position. In this case set P may contain three points, corresponding to three corners of a rectangular interaction structure **72**. Each point C(i) (0<i<4) in set P would then be uniquely determined by the intersection of a line from set A and a line from set B if and only if sets A and B contained three lines each.

If the decision at **90***e* is negative, the program continues to **90***f*, where line B(b+1) is added once more to set B.

If the decision at **90***e* is positive, program flow continues to **90***g*. The program flow may also continue from **90***f* to **90***g*. At **90***g* a decision is made whether counter b has reached zero, in which case the lines left in set B (which number may be equal to zero) are deemed necessary for unique determination of the coordinates of all the points in set P. If the decision at **90***g* is positive, program flow continues to **90***h*. If the decision at **90***g* is negative, program flow reverts to **90***d*.

During **90***h*, line A(a) is removed from set A, after which counter a is decremented by 1. Program flow then continues to **90***i*, where a decision is made whether complete 3D information on the lines in sets A and B, together with the a priori information, constitute enough information to uniquely determine the coordinates of all the points in set P.

If the decision at **90***i* is negative, program flow continues to step **90***j*, where line A(a+1) is added once more to set A.

If the decision at **90***i* is positive, program flow continues to step **90***k*. The program flow also continues from **90***j* to **90***k*. At **90***k*, a decision is made whether counter a has reached zero, in which case the lines left in set A (which number may be equal to zero) are deemed necessary for unique determination of the coordinates of all the points in set P. If the decision at **90***k* is negative, program flow reverts to **90***h*. If the decision at **90***k* is positive, program flow continues to **90***m*, the details of which are described with reference to FIG. **5**.

In FIG. **5**, the program continues to **100***a*, where counter p is initialized to 1 and variable n is set to the number of points in set P.

Program flow then continues to **100***b* where a decision is made whether line A(p) (connecting point CA to point C(p)) is included in set A. If the decision is negative, program flow continues to **100***c*, where counter p is incremented by 1.

If the decision at **100***b* is positive, program flow continues to **100***e*, at which the program identifies point C(p) to the user and then can query the user to highlight this point using light-beam projection device **202**, preferably from a position such as point CA, as determined previously at **90***a* (FIG. **4**). The user can also be queried to affirm the highlighting action by, for example, activating one of the buttons **203***a* or **204***b*, or the like. The identification of point C(p) may occur, for example, by having the program display a visible screen mark **521***a*-**521***d* at a position on computer screen interaction region **51** associated with C(p), which may then be projected by projection device **40** to coincide with point C(p). Other means of identification are also possible, such as the characterization of point C(p) as 'upper-right corner' or the like.

Program flow then continues on to **100***f*, where the program can wait until the highlighting action is affirmed by the user, after which the 3D orientation of the z'-axis and the 3D position of the z'=0 point (of the z'-axis) are measured with respect to the x y z coordinate system, using coordinate sensing device **201** and **301**, and communicated to the computer using communication and control device **204** and/or **304**. This 3D orientation and position is then associated with line A(p) and stored in memory. Program flow then continues to **100***c*.

After **100***c* program flow continues to **100***d* where a decision is made whether p is equal to n+1. If the decision is positive, it can be concluded that all necessary data on lines A(p) have been ascertained and program flow can continue to **100***g*. If the decision at **100***d* is negative, program flow reverts to **100***b*.

At **100***g* a decision is made whether set B is empty. If the decision is positive, it can be concluded that enough information to uniquely determine the 3D coordinates of all the points in set P is contained in the a priori relationships combined with the available data on the lines in set A, and program flow continues to **100***p*. If the decision at **100***g* is negative, program flow continues to **100***h*.

At **100***h* counter p is again initialized to 1. The user is subsequently required to reposition the pointing device **20** to a different location, displacing it substantially parallel to projection region **60** over a distance substantially equal to the distance between projection region **60** and his or her present location. Other locations may also be used.

Flow then continues to **100***i* where a decision is made whether line B(p) (connecting point CB to point C(p)) is included in set B. If the decision is negative, program flow continues to **100***j* where counter p is incremented by 1.

If the decision at **100***i* is positive, program flow continues to **100***m*, at which point the program identifies point C(p) to the user and can query the user to highlight this point using light-beam projection device **202**. The program can also

query the user to affirm the highlighting by, for example, activating one of the buttons **203***a* or **204***b* or the like. The identification of point C(p) may occur, for example, by having the program display a visible screen mark **521***a*, **521***b*, . . . at a position on computer screen interaction region **51** associated with C(p), which may then be projected by projection device **40** to coincide with point C(p). Other means of identification are also possible, such as the characterization of point C(p) as 'upper-right corner' or the like.

Program flow then continues to **100***n*, where the program may wait until the highlighting action is affirmed. After affirmation, the 3D orientation of the z'-axis and the 3D position of the point z'=0 (of the z'-axis) are measured with respect to the x y z coordinate system, using coordinate sensing device **201** and **301**, and are communicated to the program using communication and control device **204** and/or **304**. The 3D orientation and position are then associated with line B(p) and can be stored in memory. Program flow then continues to **100***j*.

After **100***j* program flow continues to **100***k* where a decision is made whether p is equal to n+1. If the decision is positive, it is concluded that all necessary data for lines B(p) has been ascertained and program flow continues to **100***p*. If the decision is negative, program flow reverts to **100***i*.

At **100***p* it is concluded that the combined information of the a priori relationships and the data for lines in sets A and B that is stored in memory is enough to establish the coordinates of all points in P, as is further explained with reference to FIG. **6**.

Referring to FIG. **6**, as will be appreciated by those skilled in the art, at **110***a* the available information contained in the a priori relationships and the orientations and positions of the lines in sets A and B may be used to establish the coordinates of each of the points in set P, all measured with respect to the x y z coordinate system. It may happen that the 3D data associated with lines A(p) and B(p) ($1<p<n+1$) cause them not to intersect at point C(p); for example, this could be the case due to insufficient accuracy in determining the orientations and positions of lines A(p) and B(p). Under such circumstances point C(p) may be estimated or determined in such a way that it lies halfway along the shortest line-segment that connects lines A(p) and B(p). Other methods for determining point C(p) are also possible.

Once the complete 3D description of interaction structure **72** has been established (given the available data and assumptions), program flow continues to **110***b*. At **110***b*, a method M is constructed that maps points of interaction structure **72** to computer screen interaction region **51**. Such methods are well known to those skilled in the art. For example, a method such as that described in U.S. Pat. No. 6,373,961 to Richardson et al. (2002) may be used, but other appropriate methods may also be used. For completeness, the method disclosed in the Richardson et al. '961 patent will briefly be explained here. Referring to FIG. **20**, interaction structure **72** may be defined by line segments JK and ML. Furthermore, point F may define point-of-aim **210**, which is also the intersection between the z'-axis and interaction structure **72**. The line segments JK and ML are generally not parallel. If not parallel, then the line segments JK, ML are extended until they meet at a point H. Then a line is drawn through F and H, that intersects segment. JM at point P and segment KL at point O. If the segments JK and ML are parallel, the a line is drawn instead through F that is parallel to JK, and which intersects the other two line segments as described. The process continues similarly with the other segments, which are extended to meet at point G. A line through F and G intersects segment JK at point R and segment ML at point Q. Subsequently, the following

distances are measured and noted as percentages: JR/JK, KO/KL, LQ/LM and MP/MJ. Then four points S, T, U, V are chosen as shown in FIG. **20**, that form an exact rectangle STUV; this rectangle may define computer screen interaction region **51**. Further, points W, X, Y, Z are chosen on the sides of the rectangle STUV in such a way that SZ/ST=JR/JK, TW/TU=KO/KL, UX/UV=LQ/LM and VY/VS=MP/MJ. Then the points Z and X are joined by a line, and the points Y and W are joined by a line. The point of the intersection of these latter two lines is N, which is the point that results from the operation of method M.

Referring once again to FIG. **6**, after **110***b*, program flow continues to **110***c* where a decision is made whether the user has requested the program to end. If the decision is positive, the program ends at **110***k*.

If the decision at **110***c* is negative, program flow continues to **110***d*, where a decision is made regarding whether the user has requested a direct-pointing action, such as activating button **203***a* or **203***b* or the like.

If the decision at **110***d* is negative, program flow continues to **110***e*, where the light-beam projection device **202** can be instructed or caused to de-activate (using, for example, control device **204** and/or **304**). Furthermore, a software routine (not shown) that controls computer cursor **501** (see also FIG. **2**) is instructed that the user does not want to execute a direct-pointing action, after which program flow reverts to **110***c*. Such cursor control routines are well known to those skilled in the art and are therefore not described here.

If the decision at **110***d* is positive, program flow continues to **110***f*, where a decision is made whether the z'-axis intersects interaction structure **72**. Those skilled in the art will appreciate that this is possible because all relevant 3D information is known or is measurable by coordinate sensing device **201** and **301**. If the decision is positive, program flow continues to **110***h*, at which method M is used to map the intersection point of the z'-axis with interaction structure **72** to computer screen interaction region **51**. This mapped position, as well as the user's desire to execute a direct-pointing action are communicated to the cursor control routine (not shown) running on the computer.

After **110***h*, program flow continues to **110***i* where a decision is made whether the user wishes to execute an action associated with the position of cursor **501**. For example, activating button **203***a* or **203***b* or the like may indicate such a request. If the decision is negative, program flow reverts to **110***c*.

If the decision at **110***i* is positive, program flow continues to **110***j*, where the cursor control routine (not shown) is requested to execute the intended action. Such an action may, for instance, be a 'double-click' action or the like. Program flow then reverts to **110***c*.

There may be situations for which the system of equations that allows determination of all coordinates of the points in set P will be somewhat ill-posed. This could for example occur if locations CA and CB are chosen too close together, or if the angles of some pointing lines **21** with respect to interaction region **71** are too small, as will be appreciated by those skilled in the art. In such cases, the user may be directed to choose a different point for locations CA and/or CB from where the various points C(p) are to be highlighted.

Thus, methods and means are disclosed that afford a highly flexible and easily deployable system for interacting with a presentation in a direct-pointing manner at a location not specifically designed or adapted for such a purpose. Moreover, although it is desirable to have highly accurate coordinate sensing device **201** and **301**, in some instances such may not be necessary because the visual feedback afforded by a

displayed cursor will compensate to a large extent for any errors made in the measurements of coordinate parameters. The same holds true for the importance of any discrepancies between the actual shape of interaction region **71** and that of the interaction structure **72** that is assumed to coincide with it. Also, minor discrepancies between the actual position and orientation of interaction region **71** and the assumed position and orientation of interaction structure **72** (which is assumed to coincide with interaction region **71**) need not be of critical importance, as will be appreciated by those skilled in the art.

Mathematically, there are infinite possible shapes for interaction structure **72** as well as infinite a priori relationships, sets P, A, B and methods M. To further explain the invention, what follows is a list of examples that are believed will be encountered most often. These examples are not meant to restrict the scope of the present invention in any way, but merely serve as further clarification.

Referring to FIG. **7**, it can be assumed that the venue where the presentation is to be made is set up such that projection image **70** and interaction region **71** are substantially rectangular. Such may be the case when the optical axis of projection device **40** is substantially parallel to the normal to projection region **60**. Projection region **60** may be a projection screen on a stand, as shown, but may also be a wall or any other substantially vertical surface. It can also be assumed that the bottom and top edges of both projection image **70** and interaction region **71** are substantially horizontal. Furthermore, it can be assumed that interaction region **71** is substantially the same size as projection image **70** and that computer screen interaction region **51** is substantially the same size as computer screen image **50**. Additionally, it can be assumed that calibration points **721***a*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***d*. Finally, it is assumed that base station **30** is positioned such that the x-y-plane is substantially horizontal and the x-z-plane substantially coincides with the plane of interaction region **71**. To facilitate in the positioning of base station **30**, the user may be aided by level-sensing device **303** and visible markings **302**.

Referring to FIGS. **3** and **7**, process elements **80***a-j* may then result, either through default settings or through user-supplied settings, in the assumptions that interaction structure **72** is a rectangle that lies in the x-z plane and that its top and bottom edges are parallel to the x-y plane.

Referring to FIGS. **4** and **7**, program element **90***a* may then result in a set P containing three points that define the upper-right corner C(**1**), the upper-left corner C(**2**) and the lower-left corner C(**3**) of interaction structure **72**. Additionally, program element **90***a* may determine point CA (not denoted as such in FIG. **7**) to lie away from projection region **60**, for example at the center of one of the two instantiations of pointing device **20**, as shown in FIG. **7**. Point CB may be determined anywhere in space. Program element **90***a* may also result in sets A and B each containing three lines, connecting the points in set P to points CA and CB respectively. Program element **90***c* may then result in a priori relationships such that all points in set P have y-coordinate equal to zero, that the upper-left corner will have an x-coordinate equal to the x-coordinate of the lower-left corner and that its z-coordinate will be equal to the z-coordinate of the upper-right corner. It will then be appreciated by those skilled in the art that this a priori information, together with complete 3D information on two lines in set A will be sufficient to uniquely determine the position, size and orientation of interaction structure **72** with respect to the x y z coordinate system. Therefore, program elements **90***d*, **90***e*, **90***f*, **90***g* may result in an empty set B. Moreover, program elements **90***h*, **90***i*, **90***j*, **90***k* may result in the removal from set A of line A(**2**), connecting point CA to point C(**2**).

Referring to FIGS. **5** and **7**, program elements **100***a-p* may result in the program identifying point C(**1**) by instructing the computer (not shown) and projection device **40** to project screen mark **521***a* onto projection region **60**, resulting in the appearance of calibration point **721***a*. Subsequently, the user is required to use light-beam projection device **202** to highlight calibration point **721***a* and indicate the success of this action to the computer (not shown) by, for example, pressing button **203***a*. As a result, the orientation and position of the z'-axis are assumed to define line A(**1**). The same actions are then performed for point C(**3**) and line A(**3**). Since set B is empty, the user need not be required to reposition pointing device **20**. The two depictions of pointing device **20** in FIG. **7** are meant to illustrate that pointing device **20** only needs to be redirected and not repositioned during this exercise. It will be appreciated by those skilled in the art that program element **100***p* will then successfully result in a full 3D description of the three points in set P.

Referring to FIGS. **6** and **7**, program element **110***a* may then result in the description of interaction structure **72** as a rectangle with upper-right corner C(**1**), upper-left corner C(**2**) and lower-left corner C(**3**). Step **110***b* may then result in a method M that maps a point δ (not shown) in interaction structure **72** to a point ϵ (not shown) in computer screen interaction region **51** in such a way that the ratio of distances between δ and any two of the four corners of interaction structure **72** is the same as the ratio of distances between ϵ and the two corresponding corners of computer screen interaction region **51**, as will be appreciated by those skilled in the art. Steps **110***c-k* may then result in a very intuitive cursor control device that responds to a direct-pointing action by de-activating light-beam projection device **202** and showing cursor **501** at substantially point-of-aim **210** of pointing device **20** whenever point-of-aim **210** lies in projection image **70** (which in this example, by assumption, substantially coincides with interaction region **71**). Since there is no necessity for a computer generated cursor and a light spot to be visible simultaneously there will not be any cause for confusion as to which of the two is the 'actual cursor'. Cursor **501** may be hidden from view when point-of-aim **210** does not lie in interaction structure **72**, in which case light-beam projection device **202** may be activated automatically. Also, intuitive actions such as 'double click' may be provided by steps **110***c-k*.

Referring to FIG. **8**, it can be assumed that the venue where the presentation is to be given is set up such that projection image **70** and interaction region **71** are substantially rectangular. Such may be the case when the optical axis of projection device **40** is substantially parallel to the normal to projection region **60**. Projection region **60** may be a projection screen on a stand, as shown, but may also be a wall or any similar surface. Projection region **60** can be assumed to be oriented substantially vertically. It can also be assumed that the bottom and top edges of both projection image **70** and interaction region **71** are substantially horizontal. Furthermore, it can also be assumed that interaction region **71** is substantially the same size as projection image **70** and that computer screen interaction region **51** is substantially the same size as computer screen image **50**. Additionally, it can be assumed that calibration points **721***a*, **721***c*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***c*, **521***d*. Finally, it can be assumed that base station **30** is positioned such that the x-y-plane is substantially horizontal. No assumptions are made regarding the x-z-plane and the y-z-plane other than that they are substantially vertical. To facilitate in the positioning of base station **30**, the user may be aided by level-sensing device **303**.

Referring to FIGS. **3** and **8**, program elements **80***a-j* may then result, either through default settings or user-supplied settings, in the assumptions that interaction structure **72** is a rectangle of which the top and bottom edges are parallel to the x-y-plane (i.e., they are horizontal) and the left and right edges are perpendicular to the x-y-plane (i.e., they are vertical).

Referring to FIGS. **4** and **8**, program element **90***a* may then result in a set P containing three points that define the upper-left corner C(**1**), the upper-right corner C(**2**) and the lower-left corner C(**3**) of interaction structure **72**. Additionally, program element **90***a* may determine point CA (not denoted as such in FIG. **8**) to lie away from projection region **60**, for example, at the center of one of the three instantiations of pointing device **20**, as shown in FIG. **8**. Point CB (not denoted as such in FIG. **8**) may be determined to be displaced from point CA in a direction substantially parallel to interaction region **71**, over a distance that may be the same order of magnitude as the size of interaction region **71**. Program element **90***a* may also result in sets A and B each containing three lines, connecting the points in set P to points CA and CB respectively. Program element **90***c* may then result in a priori relationships requiring that the upper-left corner will have x- and y-coordinates equal to the x- and y-coordinates of the lower-left corner and that its z-coordinate will be equal to the z-coordinate of the upper-right corner. As will be explained in detail below, the a priori information together with complete 3D information on two lines in set A and one line in set B will be enough to uniquely determine the position, size and orientation of interaction structure **72** with respect to the x y z coordinate system. Therefore, program elements **90***d*, **90***e*, **90***f*, **90***g* may result in set B containing only line B(**3**). Moreover, program elements **90***h*, **90***i*, **90***j*, **90***k* may result in set A containing only lines A(**1**) and A(**2**)

Referring to FIGS. **5** and **8**, program elements **110***a-p* may result in the program identifying point C(**1**), C(**2**) and C(**3**) by means of projection device **40**, in a manner similar to the one described in the previous example. In this case, however, C(**1**) and C(**2**) may be highlighted from approximately the same location CA, but C(**3**) needs to be highlighted from a different location CB. To explain that the above-mentioned information is enough to uniquely establish the position, size and orientation of interaction structure **72**, define the points in set P as:

$$C(1) = \begin{pmatrix} x_1 + \lambda_1 \cdot Rx_1 \\ y_1 + \lambda_1 \cdot Ry_1 \\ z_1 + \lambda_1 \cdot Rz_1 \end{pmatrix} \tag{1}$$

$$C(2) = \begin{pmatrix} x_1 + \lambda_2 \cdot Rx_2 \\ y_1 + \lambda_2 \cdot Ry_2 \\ z_1 + \lambda_2 \cdot Rz_2 \end{pmatrix} \tag{2}$$

$$C(3) = \begin{pmatrix} x_3 + \lambda_3 \cdot Rx_3 \\ y_3 + \lambda_3 \cdot Ry_3 \\ z_3 + \lambda_3 \cdot Rz_3 \end{pmatrix} \tag{3}$$

Here, points CA and CB are defined as (x_1, y_1, z_1) and (x_3, y_3, z_3) respectively. Moreover, lines A(**1**), A(**2**) and B(**3**) are defined as passing through CA, CA and CB respectively, lying in directions governed by (Rx_1, Ry_1, Rz_z), (Rx_2, Ry_2, Rz_2) and (Rx_3, Ry_3, Rz_3). All of these quantities are presumed to be measured by coordinate sensing device **201** and **301**. For a unique description of the points in set P a solution is required for λ_1, λ_2 and λ_3.

Using these definitions the conditions described above can be written as:

$$\begin{bmatrix} Rz_1 & -Rz_2 & 0 \\ Rx_1 & 0 & -Rx_3 \\ Ry_1 & 0 & -Ry_3 \end{bmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} 0 \\ x_3 - x_1 \\ y_3 - y_1 \end{pmatrix} \tag{4}$$

which can be solved in a straightforward manner according to the expression:

$$\begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} [Rx_3 \cdot (y_3 - y_1) + Ry_3 \cdot (x_1 - x_3)] / [Rx_3 \cdot Ry_1 - Rx_1 \cdot Ry_3] \\ [Rz_1 / Rz_2] \cdot [Rx_3 \cdot (y_3 - y_1) + Ry_3 \cdot (x_1 - x_3)] / \\ [Rx_3 \cdot Ry_1 - Rx_1 \cdot Ry_3] \\ [Rx_1 \cdot (y_3 - y_1) + Ry_1 \cdot (x_1 - x_3)] / [Rx_3 \cdot Ry_1 - Rx_1 \cdot Ry_3] \end{pmatrix} \tag{5}$$

Note that this solution shows that, if point C(**3**) was highlighted from any point on pointing line **21** that is used to highlight point C(**1**), i.e.,

$$\begin{pmatrix} x_3 \\ y_3 \\ z_3 \end{pmatrix} = \begin{pmatrix} x_1 + \tau \cdot Rx_1 \\ y_1 + \tau \cdot Ry_1 \\ z_1 + \tau \cdot Rz_1 \end{pmatrix} \tag{6}$$

the solution for the three unknown λ's would collapse to

$$\begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} \tau \\ \tau Rz_1 / Rz_2 \\ 0 \end{pmatrix} \tag{7}$$

making unique determination of interaction structure **72** impossible. Conversely, the fact that points C(**1**) and C(**2**) are, in this example, both highlighted from substantially the same point CA does not cause any problems. It will be appreciated by those skilled in the art that C(**1**) and C(**2**) may also be highlighted from different points, without loss of functionality.

Referring to FIGS. **6** and **8**, the course and results of program elements **110***a-k* will be similar to those described in Example 1.

Referring to FIG. **9**, in another example, the only assumptions made are that interaction region **71** is substantially the same size as projection image **70**, computer screen interaction region **51** is substantially the same size as computer screen image **50**, calibration points **721***a*, **721***b*, **721***c*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***b*, **521***c* and **521***d* and computer screen interaction region **51** is substantially rectangular. This situation may arise when the optical axis of projection device **40** is not aligned with the normal to projection surface **60**.

Referring to FIGS. **3** and **9**, program elements **80***a-j* may then result, either through default settings or user supplied settings, in the assumption that interaction structure **72** is a quadrangle; no assumptions are made regarding its position or orientation.

Referring to FIGS. **4** and **9**, program elements **90***a* may then result in a set P containing four points that define the upper-right, upper-left, lower-right and lower-left corners of interaction structure **72**. Additionally, program element **90***a* may conceive point CA (not denoted as such in FIG. **9**) to lie

away from projection region **60**, for example at the center of the first of the two instantiations of pointing device **20**, as shown in FIG. **9**. Point CB may, for example, be determined to lie at the center of the second of the two instantiations of pointing device **20**, as drawn in FIG. **9**. Now, program elements **90***d*, **90***e*, **90***f*, **90***g* and steps **90***h*, **90***i'*, **90***j*, **90***k* may result in sets A and B each containing 4 lines.

Referring to FIGS. **5** and **9**, program elements **110***a-p* may result in the program identifying the four points in set P by means of projection device **40**, in a manner similar to the one described in Example 1. In this case, however, all four points in set P may be highlighted from approximately the same location CA first, after which all four points may be highlighted from approximately the same location CB. Note that FIG. **9**, for reasons of clarity, only depicts the highlighting of calibration point **721***a*. Each point C(i) may then be constructed as the point lying halfway the shortest line segment connecting lines A(i) and B(i); this line segment may have zero length.

Referring to FIGS. **6** and **9**, the course and results of program elements **110***a-k* will be similar to those described with respect to the first example, with the exception of program element **110***b*, the mapping element. Now, a more elaborate method M is needed than the one described in previous examples. For example, a method such as described in U.S. Pat. No. 6,373,961 to Richardson (2002) may be utilized, but other appropriate methods may also be used.

A second embodiment will now be made with reference to FIG. **10**, which shows pointing device **20** and base station **30**. Here, in addition to any or all of the elements mentioned in the previous embodiment, pointing device **20** is also provided with distance measuring device **206**, the position and orientation of which with respect to the x' y' z' coordinate system may be ascertained at the place of manufacture thereof and will be presumed to be known. Distance measuring device **206** may for example be embodied by a focus adjustment, or optical sensor. A digital camera may also be used. Distance measuring device **206** may determine the point-of-aim-distance **211** between the origin of the x' y' z' coordinate system and the point-of-aim, measured substantially parallel to the z'-axis (see also FIG. **2**). The point of aim **210** may lie on projection region **60**, on which interaction region **71** may lie. Distance measuring device **206** may have associated with it a manual focus adjustment that may be adjusted by the user (manual focus adjustment not shown). Alternatively, distance measuring device **206** may comprise a circuit (not shown) that automatically determines the point-of-aim-distance **211** between the origin of the x' y' z' coordinate system and the point-of-aim. For example, if the point-of-aim lies on projection region **60**, distance measuring device **206** may bounce light off of projection region **60**. In doing so, use may for instance be made of light-beam projection device **202**. Any other appropriate mechanism for determining distance may also be used for distance measuring device **206**. The optical axes of light-beam projection device **202** and distance measuring device **206** may coincide, for instance by making use of partially-reflecting elements (not shown) such as disclosed in U.S. Pat. No. 4,768,028 to Blackie (1988).

The operation of the present embodiment will now be described with reference to FIGS. **2**, **10**, and **3**. The process elements in FIG. **3** will be identical to the ones described in the first embodiment, resulting in similar assumptions regarding the shape of interaction region **71** (and interaction structure **72**) and possibly orientation and position of interaction structure **72**.

Referring to FIG. **11**, instead of the program elements described above with reference to FIG. **4**, program flow now continues at **120***a*. Program elements **120***a*-**120***h* are shown to be similar to program elements **90***a*-**90***m* (FIG. **4**), except that only point CA, set A and counter a are considered. That is to

say, in the present embodiment it is no longer necessary to determine the second point CB and associated repositioning of pointing device **20** during the calibration procedure.

After program element **120***h*, program flow continues with program elements outlined in FIG. **12**. Referring to FIG. **12**, program elements **130***a*-**130***g* are seen to be similar to steps **110***a*-**110***p* (FIG. **5**). Comparing program element **130***f* with program element **110***f* (FIG. **5**), it can be seen that at **130***f* the program also stores information on the point-of-aim-distance (**211** in FIG. **2**) between the origin of the x' y' z' coordinate system and point C(p). Comparing elements **130***g* and **100***p* (FIG. **5**), it can seen that these point-of-aim-distances (**211** in FIG. **2**) are also used in determining the 3D coordinates of the points in set P.

With complete information on the 3D coordinates of the points in set P, it is then possible to construct a 3D description of interaction structure **72** (in FIG. **2**). Therefore, program elements **110***a*-**110***k* as described above with reference to FIG. **6** may also be followed in the present embodiment.

Thus, methods and means are disclosed that afford a highly flexible and easily deployable system for interacting with a presentation in a direct-pointing manner at a location not specifically equipped for such a purpose. Moreover, when utilizing the second preferred embodiment it is often sufficient for the user to highlight various calibration points **721***a*, **721***b*, . . . from one and the same position, making the calibration procedure even more easy to follow.

Another embodiment will now be explained with reference to FIG. **13**. FIG. **13** shows another embodiment of the pointing device **20**. Pointing device **20** may be equipped with any or all of the elements mentioned in the other embodiments, such as described above with reference to FIG. **1** and FIG. **10**. The present embodiment may include a base station **30** that has associated with it a coordinate system x y z. However, in the present embodiment it can be assumed that the position of pointing device **20** will remain substantially unchanged relative to interaction region **71** over an extended period of time, and that the origin of coordinate system x y z may be assumed to be virtually anywhere instead of being related to the base station **30**. Furthermore, if any of the axes of the x y z system are chosen to be related to (locally) well-established, independent and stationary directions such as, for example, the Earth's magnetic field and/or the Earth's gravitational field, the Earth itself may be interpreted as embodying base station **30**. Under such circumstances there may not be a need for an artificial base station **30**; coordinate sensing device **201** may then, for example, be embodied by devices sensing the directions of the Earth magnetic and gravitational fields, such as accelerometers and a compass (for example, model no. HMR3300 device as manufactured by Honeywell International Inc., Morristown, N.J.), and communication and control device **204** may be configured to communicate directly with the computer (not shown).

The operation of the present embodiment will now be described with reference to FIGS. **8**, **13**, and **3**. The remainder of the description of the present embodiment will, for purposes of explanation, include the assumption that any separately embodied base station **30** (FIGS. **8** and **13**) is omitted entirely. It is also assumed that one of the axes of the orthogonal coordinate system x z is substantially parallel to the Earth's gravity field (or has a defined relationship thereto), while the second and third axes of the coordinate system are in a fixed, known relationship to the at least one geographically defined axis. In the present embodiment it is assumed that the relative position of pointing device **20** with respect to interaction region **71** remains substantially unchanged, therefore the origin of coordinate system x y z will, for purposes of explanation, be chosen to coincide with a fixed point in the pointing device **20**. For the purpose of the present embodi-

ment, it should be understood that the three instantiations of pointing device **20** as shown in FIG. **8** substantially coincide.

It can be assumed in the present embodiment that a display system is arranged at the venue where a presentation is to be made, as a combination of a portable projection device **40** and projection surface **60**, for example a wall. It will furthermore be assumed that this display system is connected, using appropriate means, to the computer (not shown) that generates the

Upon arriving at the venue, the user connects pointing device **20** to the computer (not shown), for example via a USB connection (not shown), or using a wireless relay device (not shown). Also, the computer may recognize the connection and start a program, part of which may be contained in communication and control device **204** or in control logic contained in the wireless relay device itself (not shown). Alternatively, the user may be required to load the program into the computer manually via a CD drive, a floppy drive, memory stick or the like (not shown). In any case, the program may initiate a calibration routine that has as its object establishing the shape, position, size and orientation of a well-defined interaction structure **72**, relative to the x y z coordinate system, wherein the interaction structure **72** is assumed to substantially coincide with a scaled and parallel version of interaction region **71**. The flow of this program will be explained with reference to FIG. **3**.

At **80***a* the program is initiated. At **80***b* defaults are entered for interaction region **71**. Specifically, interaction region **71** is assumed to be a substantially parallel and scaled version of a well-defined interaction structure **72**. Moreover, the respective corners of interaction region **71** and interaction structure **72** are assumed to substantially lie on lines intersecting each other in the origin of coordinate system x y z. It should be noted that FIG. **8** shows an interaction region **71** and an interaction structure **72** that are almost coincident, but this is only meant for illustrative purposes and is not a limitation on the scope of the invention. Again referring to FIG. **3**, at **80***b* default values are also established for the orientation and position of the interaction structure **72**. For example, the default values may provide that interaction region **71** is substantially a parallel and scaled version of an interaction structure **72** that is a flat rectangle of which the two most vertical sides are substantially parallel to the Earth's gravitational field, and of which the two most horizontal sides are substantially perpendicular to the Earth's gravitational field; moreover, the default values may provide that the respective corners of interaction region **71** and interaction structure **72** substantially lie on lines intersecting each other in the origin of coordinate system x y z. The default values may furthermore provide that the position of interaction structure **72** is such that the distance between pointing device **20** and the lower left corner of interaction structure **72** is equal to 1. Note that other values for the foregoing distance may be equally valid in the present embodiment. Based on the foregoing default values, calibration points **721***a*, **721***c*, **721***d*, . . . can define characteristic features of interaction region **71** and can also define characteristic features of interaction structure **72**.

At **80***c* a decision is made whether the default values for interaction region **71** and interaction structure **72** should be accepted or overridden by the user. If the default values are to be accepted, the program flow continues to **80***j*, the details of which are explained below with reference to FIG. **11**. If the defaults are to be overridden, the program flow continues with elements **80***d*-**80***i*, during which the user may override any of the default settings. The user may be aided during program elements **80***d*-**80***i* by a library of predetermined shapes, predetermined orientations and/or predetermined positions. Alternatively, the user can be provided with the capability to construct custom shapes, orientations and/or positions. In any event, program flow continues to **80***j*.

Referring to FIG. **11**, program flow now continues to **120***a*. Program elements **120***a*-**120***h* are substantially similar to program elements **90***a*-**90***m* (FIG. **4**), except that only point CA, set A and counter a are considered. In the present embodiment it is not required to determine a second point CB and an associated repositioning of pointing device **20** during the calibration procedure.

After **120***h*, program flow continues with elements described with reference to FIG. **14**. In FIG. **14**, program elements **140***a*-**140***g* are shown to be similar to steps **130***a*-**130***g* (FIG. **12**). Comparing element **140***f* with element **130***f* (FIG. **12**), it can be seen that element **140***f* does not include storing information for any directly measured distance. Element **140***f* need not include storing information on the position of the z'-axis, because the position of pointing device **20** is assumed to remain substantially unchanged over an extended period of time. Comparing elements **140***g* and **130***g*, it can be seen that any directly measured distance is not needed to determine the 3D coordinates of the points in set P (see FIG. **4**). In fact, having the default distance (set to 1) between pointing device **20** and the lower left corner of interaction structure **72** is sufficient for operation of the system in the present embodiment. To explain this fact, reference is again made to FIG. **8**. Using the above default values, interaction structure **72** will be completely defined by, for example, its upper-left corner C(**1**), its upper-right corner C(**2**) and its lower-left corner C(**3**)

$$C(1)=\lambda_1\cdot\begin{pmatrix}Rx1\\Ry1\\Rz1\end{pmatrix} \tag{8}$$

$$C(2)=\lambda_2\cdot\begin{pmatrix}Rx2\\Ry2\\Rz2\end{pmatrix} \tag{9}$$

$$C(3)=\lambda_3\cdot\begin{pmatrix}Rx3\\Ry3\\Rz3\end{pmatrix} \tag{10}$$

lying on lines A(**1**), A(**2**) and A(**3**) that connect the origin to points (Rx_1, Ry_1, Rz_1), (Rx_2, Ry_2, Rz_2) and (Rx_3, Ry_3, Rz_3) respectively. Using these definitions, the conditions described above determine relationships between the various variables that can be written as

$$\begin{bmatrix}Rz_1 & -Rz_2 & 0\\ Rx_1 & 0 & -Rx_3\\ Ry_1 & 0 & -Ry_3\end{bmatrix}\begin{bmatrix}\lambda_1\\ \lambda_2\\ \lambda_3\end{bmatrix}=\begin{pmatrix}0\\0\\0\end{pmatrix} \tag{12}$$

which will have non-trivial solutions only if the determinant of the matrix equals zero. Then, it can be shown that any combination of $(\lambda_1, \lambda_2, \lambda_3)$ that can be written in the form:

$$\begin{pmatrix}\lambda_1\\ \lambda_2\\ \lambda_3\end{pmatrix}=\begin{pmatrix}Rz2/Rz1\\ 1\\ (Rz2\cdot Rx1)/(Rz1\cdot Rx3)\end{pmatrix}\cdot\alpha \tag{13}$$

where α is any arbitrary real number, will generate solutions for interaction structure **72** that are parallel to each other. The assumption that the distance between pointing device **20** and the lower left corner of interaction structure **72** is 1 will hence uniquely generate one of these solutions. To see that

other assumptions regarding this distance do not influence the operation of the present embodiment, reference is made to FIG. **15**. In FIG. **15**, projections of two parallel solutions for interaction structure **72** are shown, obtained for different values of distances CA-C(**3**). When it is assumed, for purposes of explanation, that these two solutions are parallel to the z-x plane, FIG. **15** may be interpreted as a projection of the two solutions onto the x-y plane. These projections are shown as the thick line segments C(**3**)-C(**2**) and CC**3**-CC**2**. FIG. **15** also shows the projection of point CA (i.e., the origin of coordinate system x y z), from where the lower left and upper right corners of interaction structure **72** were highlighted, and line-segments C(**3**)-CA and C(**2**)-CA which coincide with the (projections of) the highlighting lines A(**3**) and A(**2**) (not denoted as such in FIG. **15**). Finally, line-segment BB**1**-CA indicates (the projection of) a pointing line that is consistent with a point-of-aim BB**1** on the one and point-of-aim BB**2** on the other of the two solutions for interaction structure **72**. To show that BB**1** and BB**2** represent the same horizontal coordinate when measured relative to the appropriate solution for interaction structure **72**, the lengths of line-segments C(**3**)-BB**1**, C(**2**)-BB**1**, CC**3**-BB**2**, CC**2**-BB**2**, BB**1**-CA and BB**2**-CA are represented by bb**1**, bb**2**, b**1**, b**2**, aa**12** and a**12**, respectively. It is sufficient to show that bb**1**/bb**2**=b**1**/b**2**. Consider the following equalities:

$$\frac{bb1}{\sin\beta 1} = \frac{aa12}{\sin\alpha 1} \tag{14}$$

$$\frac{bb2}{\sin\beta 2} = \frac{aa12}{\sin\alpha 2} \tag{15}$$

while, at the same time

$$\frac{b1}{\sin\beta 1} = \frac{a12}{\sin\alpha 1} \tag{16}$$

$$\frac{b2}{\sin\beta 2} = \frac{a12}{\sin\alpha 2} \tag{17}$$

From this it follows that

$$\frac{aa12}{bb1} = \frac{a12}{b1} \tag{18}$$

$$\frac{aa12}{bb2} = \frac{a12}{b2} \tag{19}$$

which, in turn, provides that

$$bb1\frac{a12}{b1} = bb2\frac{a12}{b2} \Rightarrow \frac{bb1}{bb2} = \frac{b1}{b2} \tag{20}$$

This implies that BB**1** and BB**2** represent the same horizontal coordinate when measured relative to the appropriate solution for interaction structure **72**. Note that, if FIG. **15** is interpreted as a projection onto the z-y-plane, it can be concluded that BB**1** and BB**2** also represent the same vertical coordinate when measured relative to the appropriate solution of interaction structure **72**. Therefore the initial assumption that the distance between C(**3**) and CA is equal to 1 does not influence the operation of the third preferred embodiment.

It is theoretically possible that there are no non-zero solutions for the parameters λ_1, λ_2 and λ_3, when the determinant referred to above in equation (12) is non-zero. Such may be the case, for example, due to errors in measurements or in the assumed rectangular shape of interaction region **71**. In such cases additional techniques may be used to find an acceptable solution for interaction structure **72**. For example, a minimization routine may be used to find a solution for interaction structure **72** that minimizes a summation of the distances between some of its corners (which, by assumption, lie on lines connecting the origin of coordinate system x y z with the corners of interaction region **71**) and the highlighting lines.

With complete information on the 3D coordinates of C(**1**), C(**2**) and C(**3**) it is possible to construct a 3D description of interaction structure **72**. Therefore, program elements **110***a*-**110***k* as described in the first embodiment and explained above with reference to FIG. **6** may also be followed in the present embodiment.

There may be situations in which the user is not able to hold pointing device **20** continuously at precisely the same position while performing the actions required by the calibration procedure described in FIGS. **3**, **11** and **14**, or during the use of the system as a direct-pointing device. Such changes in position of the pointing device **20** can cause errors in the calculation of the point-of-aim. It will be appreciated that if the discrepancy between the calculated and the true point-of-aim is small enough, the visual feedback provided by the displayed cursor (**501** in FIG. **1**) during use of the system as a direct-pointing device will still afford the user the perception that direct-pointing is being performed.

There are many other methods capable of establishing position, size and orientation of interaction structure **72**, as will be appreciated by those skilled in the art. For example, if the distance between pointing device **20** and interaction structure **72** is presumed known, if interaction structure **72** is assumed to be rectangular with two vertical and two horizontal sides and if its aspect ratio (the ratio between its horizontal size and its vertical size) is also presumed known, then knowledge of two lines from CA to the upper-right and lower-left corner is sufficient to narrow the number of solutions for interaction structure **72** down to 2, dictated by 2 solutions of a quadratic equation. One further assumption is then required to determine which of these 2 solutions is the correct one; this assumption may be in the form of a third line passing through yet another characteristic point of interaction structure **72**, but it may also be in the form of knowledge of the (approximate) angle between the plane in which interaction structure **72** lies and a line connecting the origin to one of its corners. Other scenarios may also be conceived for which solutions may be devised that are within the scope of the general methods set forth herein.

In the present embodiment, using well-established and stationary directions such as, for example, the Earth's magnetic field and the Earth's gravitational field, it may be possible to omit a separately embodied base station, making the present embodiment of the system possibly more compact, less expensive to make and easier to deploy.

Another embodiment of a system according to the invention will now be described with reference to FIG. **16**. In the present embodiment a handheld presentation device **25** contains a power source **205**, communication and control device **204** and a directional sound recording device **251**. The sensitivity region of the directional sound recording device **251** may be substantially oriented along the long axis of presentation device **25**. Any or all of the features contained in pointing device **20**, already described in previous embodiments or to-be-described in the additional embodiments, may also be

contained in presentation device **25**; any or all of features **201**-**207** are collectively depicted as module **200**. In the same way, the fourth preferred embodiment also may but need not provide base station **30** and its associated elements, such as elements **301**-**305** or a wireless relay device (not shown in FIG. **16**).

The directional sound recording device **251** may be provided with so-called zoom capabilities, such as those afforded by, for example, the ECM-Z60 Super Zoom Microphone as manufactured by Sony. Alternatively, directional sound recording device **251** may comprise multiple directional microphones (not shown) with different sensitivity regions, so that zoom capabilities may be emulated. In these cases, presentation device **25** may also be provided with zoom control device **252**, capable of adjusting the sensitive volume of directional sound recording device **251** either by manual control or automatically. Directional sound recording device **251** may communicate with the computer (not shown) and/or base station **30** (not shown in FIG. **16**) through communication and control device **204** and/or **304** (not shown in FIG. **16**). A control program described in FIG. **17** may be transferred to the computer (not shown) or be incorporated in communication and control device **204** and/or **304**. Moreover, there may be provided a storage medium for storage of sound data (not shown) in one of the components of the described system, as well as means to play back sound, such as a loudspeaker (not shown).

During a presentation it may occur that a member of the audience wishes to communicate verbally with the presenter (user). Often, the acoustics of the room preclude other members of the audience from hearing such communication In such cases, the user may point presentation device **25** in the direction of the member of the audience who wishes to communicate with the user. The user may then activate directional sound recording device **251** by activating controls such as button **203***a* or zoom control device **252**. The latter may also be used to acoustically zoom in on the particular member of the audience. Directional sound recording device **251** may then communicate with the computer (not shown) and record the communication, for example, in computer memory (not shown). At the same or later time the user may request the recording to be played back, for instance over speakers (not shown) driven by the computer (not shown), by activating controls such as button **203***b*. The computer program may be configured such that one and the same command from the user, such as the activation of button **203***a* or zoom control device **252**, initiates substantially simultaneous recording and playback. Measures to counteract any acoustical interference when playback and recording occur almost simultaneously may be implemented as well. Such measures are well known in the art.

Referring to FIG. **17**, to facilitate the recording and playback of sounds, general elements, **150***a*-**150***q* of a program are shown. These program elements may be executed by the computer (not shown), and may be loaded into the computer by such means as floppy discs, memory sticks or CDs (not shown). The programs may be pre-loaded in base station **30**, its associated wireless relay device (both not shown in FIG. **16**) or presentation device **25**, and transferred by means of a USB port or the like (not shown) upon connecting any of these components to the computer (not shown).

At **150***a* the program is initialized, old recordings are erased and a record-flag and a playback-flag are unset; this indicates that both recording and playback are not activated.

Program flow continues to **150***b*, where a decision is made whether the user requests the program to end. Buttons (**203***a*, **203***b* in FIG. **16**) or the like may be used for this purpose.

If the decision at **150***b* is positive, program flow continues to **150***q*, where any recording or playback is stopped, playback and record flags are unset, old recordings are erased and the program ends. If the decision at **150***b* is positive, program flow continues to **150***c*.

At **150***c* a decision is made whether the user has requested sound recording. If the decision is positive, program flow continues to **150***d*. If the decision is negative, program flow continues on to **150***f*.

At **150***d* a decision is made whether the record-flag is unset, indicating that recording is not already in progress. If the decision is negative, program flow continues to **150***f*. If the decision is positive, program flow continues to **150***e*, where the record flag is set, any old recordings are erased and sound recording is started, after which the program flow continues to **150***f*.

At **150***f*, a decision is made whether the user has requested sound playback. If this decision is positive, program flow continues to **150***g*. If the decision is negative, program flow continues to **150***i*.

At **150***g* a decision is made regarding whether the playback flag is unset, indicating that playback is not already in progress. If the decision is negative, program flow continues to **150***i*. If the decision is positive, and there is some sound data to be played back, program flow continues to **150***h*, where the playback flag is set and sound playback is started, after which the program flow continues to **150***i*.

At **150***i* a decision is made whether the user has requested that sound recording is to be terminated. If the decision is positive, program flow continues to **150***j*. If the decision is negative, program flow continues on to step **150***m*.

At **150***j* a decision is made whether the record-flag has been set, indicating that recording is in progress. If the decision is negative, program flow continues to **150***m*. If the decision is positive, program flow continues to **150***k*, where the record flag is unset and sound recording is stopped, after which the program flow continues to **150***m*.

At **150***m* a decision is made whether the user has requested that sound playback is to be terminated. If the decision is positive, or if the end of the recorded sound has been reached, program flow continues to **150***n*. If the decision is negative, program flow reverts to step **150***b*.

At **150***n* a decision is made whether the playback flag has been set, indicating that playback is in progress. If the decision is negative, program flow reverts to **150***b*. If the decision is positive, program flow continues to **150***p*, where the playback flag is unset and sound playback is stopped, after which the program flow reverts to **150***b*.

Thus, methods and means are disclosed that afford a user the capability to easily capture and playback comments made by a member of the audience, even in the presence of substantial background noise.

While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, Many other variations are possible. For example, presentation device **25** or pointing device **20** may be hand held, but may also be carried by the user in a different manner, such as by means of a headset, finger-worn ring or the like.

Although the first, second and third embodiments make use of the assumption that the interaction structure **72** and interaction region **71** are quadrangles, this need not be the case even when the corresponding computer screen interaction region **51** is rectangular in shape. For example, projection region **60** may be spherical in shape. This may cause the projection of a square computer screen interaction region **51** to result in interaction region **71** having the general shape of

a sphere-segment. Other shapes are also possible, depending on a number of factors such as the angle between the optical axis of projection device **40** and projection region **60**. It will be appreciated by those skilled in the art that set P (see FIG. **4**, step **90***a* and FIG. **11**, step **120***a*) and method M (see FIG. **6**, step **110***b*) may become more complicated under these circumstances, but may still be well defined. In fact, method M and sets P, A, B may be constructed in any way that is advantageous to the particular system application. It is also possible to determine more points and associated line sets than just CA and CB, and associated line sets A and B. Specifically, set P may have more or fewer than the number of points described with reference to the foregoing embodiments, depending on the complexity of the presentation venue. Also, sets A and B may contain more lines than the minimum number needed to establish the coordinates of the points in set P.

The present invention may make use of mathematical techniques not described explicitly herein but well known to those skilled in the art to aid with various aspects of the present invention, for example in the determination of position and/or orientation of interaction structure **72**. The second example of the first embodiment, for example, was described as relying on three lines highlighting corners of the interaction structure **72**. It is also possible that a more accurate solution for the position and/or orientation of interaction structure **72** may be obtained when the user is requested to also highlight the fourth corner of the screen. An appropriate minimization routine may then be used to find a solution characterized by, for example, a minimum accumulated distance between the four corners of interaction structure **72** and the closest highlighting line.

Moreover, although set P is described as containing points that are needed to completely define interaction structure **72**, other embodiments of the invention may use so-called "control points" for quality control purposes. Such control points may be used to test the validity of the assumptions made concerning, for example, the shape, the position, size and/or orientation of interaction region **71** and, therefore, interaction structure **72**, as well as to test the accuracy of the measurements made to establish the 3D features of the various lines. As an example, consider the case in which interaction structure **72** is taken to be a rectangle for which all data needed to uniquely establish its size, orientation and position with respect to the x y z coordinate system has been ascertained by the program elements described with respect to the foregoing embodiments. Moreover, in this example interaction region **71** and, therefore, interaction structure **72**, are assumed to substantially coincide with the projection of a rectangular computer screen interaction region **51**. Then, the computer may display a suitable screen mark **521***a*, **521***b*, . . . at, for example, the center of computer screen interaction region **51**, which may be projected by projection device **40** onto projection region **60**. It will be appreciated that the process elements described herein may be used to calculate 3D coordinates of this projected point, based on the available data regarding shape, size, orientation and position of interaction structure **72**. The user may then be required to highlight the projected point using light-beam projection device **202** and indicate the success of this action to the computer by, for example, activating button **203***a*. If all measurements and highlighting actions were accurate enough and no false assumptions were made, the 3D coordinates of the projected point should substantially conform to the 3D characteristics of the z'-axis. If the discrepancy is deemed too large the user may be required to repeat part or all of the calibration steps outlined in the present invention.

There may also be more than one method M and sets P, A and B, each of which may be associated with a different interaction structure **72** and interaction region **71**. There may be more than one interaction structure **72** and interaction region **71**, each of which may, but need not, lie on projection region **60** and each of which may, but need not, be associated by means of projecting screen marks **521***a*, **521***b*, . . . , with one or more computer screen interaction regions **51**.

Although coordinate sensing device (**201** and **301** in FIG. **1**.) were in some embodiments described as being able to provide information on the 3D position and 3D orientation of pointing device (**20** in FIG. **2**) relative to the x y z coordinate system, it should be understood that such information provision requirements may be relaxed under some circumstances. Specifically, in the first embodiment it is only required that the 3D position and 3D orientation of pointing line (**21** in FIG. **2**) to be known, instead of having complete information on the position of pointing device (**20** in FIG. **2**) along the pointing line. That is, in some cases pointing device may be moved along pointing line without loss of functionality. In such embodiments the coordinate sensing devices need only provide information on the 3D position and 3D orientation of a line (as opposed to a line-segment) substantially intersecting pointing device. If coordinate sensing devices are able to provide complete 3D information (i.e., 3D position and 3D orientation) of pointing device, as opposed to pointing line, the extra positional information may, for example, be used to implement the capability to zoom in on a region around point-of-aim (**210** in FIG. **2**); other actions may also be based on the extra positional information. The foregoing capability may be inferred from the description of the third embodiment, in which the coordinate sensing device only is used to provide information on the angle between the pointing line and two other fixed lines, instead of full position and orientation information about a line segment.

Although the first, second and third embodiments describe the application of the invention as a cursor control device, the invention may also be used to facilitate non-cursor-related applications. Such applications may include "virtual writing" on the interaction region **71**, target practice and the like. Also, the invention may be used other than for presentations. For example, methods of the invention may be employed to control a cursor on a television screen in order to make selections from menus associated with such things as Digital Satellite Television; other applications may also be anticipated.

Moreover, the features of the present invention that enable the tracking of point-of-aim relative to an interaction region may be enhanced by algorithms that allow the filtering of involuntary, fast and/or small hand-movements (that may be caused, for example, by the activation of buttons). Such algorithms may be used to control a point that moves less erratically than the actual point-of-aim while still being associated with it. Such motion filtering may produce a more steady motion of cursor **501**. Such algorithms may also be used when the user is required to highlight calibration points **721***a*, **721***b*, ... Filter algorithms are well-known in the art.

The present invention also contemplates the inclusion into pointing device **20** or presentation device **25** of sensors capable of detecting motion or acceleration, both linear and angular, in addition to or as part of coordinate sensing device **201**. Such sensors may be used to detect unintended motion or acceleration of pointing device **20** or presentation device **25** that may be caused, for example, by trembling of the user's hand. The programs described above with reference to FIGS. **5**, **6**, **12** and **14** may be enhanced by algorithms that compare the output of such sensors and/or coordinate sensing device to predefined thresholds, so that a change in measured orienta-

tion and/or position by coordinate sensing device **201** may be recognized as significant only if such output exceeds these thresholds. Using threshold selection, a change in cursor position may only be affected if inferred to be intentional, avoiding the type of "jitter" associated with the use of regular laser pointers by a user with an unsteady hand.

Furthermore, pointing device **20** may be equipped with an image capturing device, such as a digital camera, preferably with zoom and controllable focus capabilities. Other image capturing devices, in combination with appropriate optical devices, may also be used. As stated before, such a digital camera may be used as an embodiment of distance measuring device **206**. Referring to FIG. **18**, such a digital camera or the like (not shown) may also be used to aid in the process of highlighting the calibration points **721***a*, **721***b* . . . . Images of calibration points **721***a*, **721***b*, . . . and light spots at point-of-aim **210** may be captured during the time when the user is engaged in the highlighting process. These images may be temporarily stored, together with the position and orientation of the z'-axis at the time the image was acquired. During the highlighting process, it is likely that point-of-aim **210** changes slightly. The resulting sequence of images may then be used to more accurately estimate the orientation and position of the pointing line **21** that connects the origin of the x' y' z' system to calibration point **721***a*, **721***b*, ... For example, an averaging algorithm may be used. Alternatively, the stored position and orientation of the z'-axis corresponding to the captured image for which the light spot at point-of-aim **210** is closest to the center of calibration point **721***a*, **721***b*, . . . may be taken as the position and orientation of the pointing line **21** that connects the origin of the x' y' z' system to calibration point **721***a*, **721***b*, ...

Some features may also be omitted without affecting the overall applicability of the present invention. For example, level-sensing device (**303** in FIG. **1**) and visible markings (**302** in FIG. **1**) may be helpful but are not of critical importance and may be omitted. If level-sensing device **303** are present, the output may also be utilized to correct the orientation of the x y z coordinate system to ensure that its x-y plane is substantially horizontal, as previously explained. In such a case, the visible markings **302** may no longer precisely indicate the position of certain coordinate planes or even the origin of the x y z coordinate system. If the orientation of the uncorrected x-y-plane with respect to a horizontal surface is small enough, though, visible markings **302** may still provide sufficiently reliable information on coordinate planes and origin of the corrected x y z coordinate system.

Furthermore, the programs outlined in FIGS. **3**, **4**, **5**, **6**, **11**, **12**, **14** and **17** may be changed appropriately without loss of functionality, particularly with respect to the order of some of the elements. The programs may also be written in any language that is advantageous to particular the implementation, including without limitation C, Java, and VisualBasic.

Other embodiments that include automatic activation and de-activation of light-beam projection device **202**, or include provision for instructing the cursor control routines to show or hide computer cursor **501** are also within the scope of the present invention. For example, automatic activation and de-activation of light-beam projection device **202** may occur depending on whether or not the z'-axis intersects one of the interaction structures **72**, or regions of space close to them. This may be performed by instructions to the cursor control routines to show or hide computer cursor **501**. Also, means may be provided to activate light-beam projection device **202** manually.

Furthermore, pointing device **20** and presentation device **25** may include a conventional, indirect pointing device such as a trackball or the like, to be used in situations where direct pointing is not possible or not desired. As a practical matter, coordinate sensing device **201**, in some embodiments in combination with coordinate sensing device **301**, may be used to affect cursor control in an indirect manner if the intended use makes this desirable. To effect cursor control in indirect pointing applications, pointing device **20** or presentation device **25** may include a user input device that enables the user to select whether indirect cursor motion control is desired, or may include sensors and/or algorithms that enable determining when direct pointing actions are not possible. For example, an algorithm or sensor may be included that enables determination of whether pointing device **20** or presentation device **25** is within the operational range of base station **30**. The third described embodiment, specifically, may be enhanced with algorithms and/or sensors, such as accelerometers, that enable to determination of whether pointing device **20** or presentation device **25** have been displaced significantly from the position at which the calibration procedure was performed, making direct pointing actions no longer possible without additional calibration steps. As part of the third described embodiment, additional input devices and algorithms may be included that enable the user to mark an orientation in space such that indirect cursor motion control may be effected based on the changes in orientation with respect to this marked orientation, as described in the cited prior art. Other embodiments of a system may also be enhanced by such functionality and input devices.

In addition to the previously described methods to determine size, position and orientation of interaction region **71**, other methods are also within the scope of the invention. These include methods based on the use of digital cameras and the like. The position and orientation of such cameras, relative to the x y z coordinate system, may be tracked by using a device such as coordinate sensing device **201** and **301**. For example, given sufficient knowledge of the optical characteristics of a digital camera, 3D features of an object may be determined from one or more images taken from one or more positions. Using such images, a complete 3D description of interaction region **71** may be determined.

Another alternative for establishing 3D position, size and orientation of interaction region **71** is provided by a digital camera or the like used in addition to, or as embodiment of, the distance measuring device **206**. In such embodiments the direction relative to the x' y' z' coordinate system of the axis along which distance is measured may be controlled and measured by mounting the digital camera and/or distance measuring device **206** in such a way that their orientation relative to the x' y' z' coordinate system may be controlled and measured. Other implementations in which the foregoing components are positionally fixed are also contemplated. For purposes of explanation, the axis along which distance is measured is denoted as the z"-axis, and the z"=0 position is assumed to coincide with the origin of the x' y' z' coordinate system. The orientation of the z"-axis with respect to the x' y' z' coordinate system, and also with respect to the x y z coordinate system may therefore be assumed to be known. In this embodiment, calibration points **721***a*, **721***b*, . . . may be displayed simultaneously, as projections of screen marks **521***a*, **521***b*, . . . , and may differ in appearance, such that they may be distinguished by image processing software. Alternatively, calibration points **721***a*, **721***b*, . . . may appear as projections of screen marks **521***a*, **521***b*, . . . in an automatically controlled sequence. The user may then be queried to direct pointing device **20** in the general direction of interaction region **71** in such a way that the digital camera may image the calibration point under consideration. An automated calibration

sequence may then be executed, wherein the z"-axis is directed, in sequence, to calibration points **721**_a_, **721**_b_, . . . etc. The image processing software may identify the various calibration points **721**_a_, **721**_b_, . . . and the 3D position of these points may then be determined from knowledge of the orientation of the z"-axis and the coordinates of the z"=0 position with respect to the x y z coordinate system, in addition to the measured point-of-aim-distance **211** between the calibration points **721**_a_, **721**_b_, . . . and the origin of the x' y' z' coordinate system. This embodiment may also provide light-beam projection device **202** mounted in a way that enables control of the direction of the light-beam relative to the x' y' z' coordinate system. This light-beam may be used to aid in positioning the z"-axis. Embodiments where light-beam projection device **202** are fixed or left out entirely are also contemplated.

The present invention also contemplates situations in which parts of the calibration procedures outlined may be repeated at appropriate times. For example, when the relative position of base station **30** and interaction region **71** changes substantially there may be a need to recalibrate the system. Such may also be the case when the position with respect to interaction region **72** of pointing device **20** or presentation device **25** changes significantly, while operation of a particular embodiment of the invention operated using the assumption that such position remains substantially unchanged. As another example, coordinate sensing device **201** and/or coordinate sensing device **301** may include time-integrated acceleration measuring devices. In such a case accuracy of coordinate sensing may deteriorate over time, because of drift in the base acceleration measurements. When the deterioration has become large enough to be unacceptable to the user, the user may be queried to place pointing device **20** in certain defined positions with respect to the x y z coordinate system, so as to re-initialize coordinate sensing device **201** and **301**.

The present invention also contemplates the use of a plurality of pointing devices **20** and/or presentation devices **25**. Each of the plurality of pointing devices **20** or presentation devices **25** may be uniquely identifiable by the computer, for example by carrying a unique ID code inside their respective communication and control device **204**. Each of the plurality of pointing or presentation devices may be associated with a specific cursor and/or a specific interaction region **71**. For example, a first pointing device may be used to control a corresponding cursor on the left-hand one of two interaction regions **71**, and a second pointing device may be used to control a corresponding cursor on the right-hand one of two interaction regions **71**. Alternatively, both pointing devices may be used to control a corresponding, identifiable cursor on the same interaction region **71**.

Furthermore, the present invention contemplates the use of a plurality of entities such as base station **30**, a particular one of which may be associated with the origin of the x y z coordinate system. Such a base station may be designated as the 'master base station'. Each of the base stations may include coordinate sensing device **201**, so that their respective position and orientation relative to the master base station can be determined with greater accuracy than that afforded by the coordinate sensing device **201** that is incorporated in pointing device **20**. Using such multiple base stations and coordinate sensing devices, 3D data pertaining to pointing device **20** may be determined relative to the closest base station, and the relative position and orientation of that base station with respect to the master base station may be used to establish the 3D data pertaining to pointing device **20** with respect to the x y z coordinate system. Alternatively, signals from multiple base stations, as measured by the coordinate sensing device **201** disposed in pointing device **20**, may be used simultaneously to reduce measurement errors. Generally speaking, determining the 3D data pertaining to pointing device **20** with respect to the x y z coordinate system by making use of only one base station **30** may be less accurate than by making use of a plurality of base stations. Hence, the effective range of operation of pointing device **20** may be enhanced by distributing a plurality of base stations over a large region of space.

Referring to FIG. **19**, in another embodiment, different devices than light-beam projection devices may be used to determine the position of the points in set P. For example, light-beam projection device **202** may be omitted in an embodiment where pointing device **20** has the general shape of an elongated body, such as a pointing stick. The length of this stick may be predetermined or variable. For example, pointing device **20** could be in the shape of an extendable, or telescopic pen such as the INFINITER Laser Baton sold by Bluesky Marketing—Unit 29, Six Harmony Row, Glasgow, G51 3BA, United Kingdom. The process of highlighting a calibration point **721**_a_ **721**_b_, . . . , in this embodiment may be replaced by the action of pointing to the calibration point **721**_a_, **721**_b_, . . . , thereby guided by the elongated shape of pointing device **20** instead of the light spot shown in FIG. **18** at point-of-aim **210**. Distance measuring device **206** may also be provided in a related embodiment, similar to the second described embodiment. For example, distance measuring device **206** may include a device to measure the distance from the tip of the elongated body of pointing device **20** to the origin of the x' y' z' coordinate system. In such an embodiment, in order to obtain measurements of point-of-aim-distance **211**, as described for example at program element **130**_f_ (see FIG. **12**), the user might be queried to make physical contact between the tip of pointing device **20** and the calibration point. Referring to FIG. **19**, pointing device **20** may also comprise contact-sensing device **207**, for example at the tip of pointing device **20**, capable of indicating physical contact between the tip of pointing device **20** and a surface. Contact-sensing device **207** may be in the form of a pressure-sensor or switch. Such sensors are known in the art.

The present invention also contemplates the use of various other sensors integrated in pointing device **20**, presentation device **25** and/or base station **30** to help determine the position and/or orientation of interaction structure **72**. For example, pointing device **20**, presentation device **25** and/or base station **30** may include ultrasonic emitting and detecting devices to enable measuring substantially the shortest distance between a known point in the x y z coordinate system (e.g., the position of pointing device **20**, of presentation device **25** or of base station **30**) and the plane in which projection region **60** lies. The user may be queried to align pointing device **20**, presentation device **25** or base station **30** such that the distance measuring device is oriented substantially perpendicularly to projection region **60**. It should be understood that other types of sensors may be included in pointing device **20**, presentation device **25** or base station **30** to help constrain the position and/or orientation of interaction structure **72**.

In some cases it may be unnecessary to provide a separately embodied base station **30**. For example, coordinate sensing device **201** may partly or completely rely on inertial sensing means such as accelerometers and gyroscopes, or on distance measurements with respect to walls, ceiling and/or floor. In such cases it would be possible to leave out base station **30** entirely and simply choose an appropriate x y z coordinate system. In such embodiments communication and control device **204** could be configured to communicate directly with the computer.

The present invention also contemplates the use of automated procedures to establish the nature of the calibration points **721**a, **721**b, **721**c, **721**d, based on the measurements of the orientation and/or position of the pointing lines **21** that substantially pass through them. For example, with reference to FIG. **7**, calibration points **721**a and **721**d need not be explicitly identified to the user as upper-right and lower-left corner respectively, but may merely be identified as diagonally opposite corners. Those skilled in the art will appreciate that in such a case an automated procedure may use the measurements of orientation and/or position of both pointing lines **21**, specifically with respect to the x-y-plane, to identify which of the two lines passes through the upper one of the two diagonally opposite corners. The practical consequence to the user is that the user need not be concerned about which of the two calibration points **721**a and **721**d is highlighted first. Similar arguments can be used to construct automated procedures that determine whether a pointing line **21** substantially passes through a left or a right corner of interaction region **71** (and, by assumption, of interaction structure **72**). For example, the a-priori assumption may be made that the clockwise angle between a pointing line **21** through a left corner and a pointing line **21** through a right corner, measured parallel to the x-y-plane, should not exceed 180 degrees, as will be appreciated by those skilled in the art.

Finally, although the methods disclosed by the present invention are described in 3D, the invention may also be applied in 2D scenarios.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. A method for controlling a parameter related to a position of a computer display cursor based on a point-of-aim of a pointing device within an interaction region, comprising:

projecting an image of a computer display to create the interaction region;

establishing at least one calibration point having a predetermined relation to said interaction region;

directing a pointing line to substantially pass through said calibration point while measuring a position of and an orientation of the pointing device, said pointing line having a predetermined relationship to said pointing device; and

controlling the parameter related to the position of the cursor within the interaction region using measurements of the position of and the orientation of the pointing device.

2. The method of claim **1**, further comprising:

initializing boundaries of the interaction region to substantially coincide with a predetermined interaction structure and formulating a description of said interaction structure, whereby said description may be used to constrain a position of at least a second calibration point.

3. The method according to claim **2**, wherein said description uses the measurements of orientation and position of the pointing device from said measuring at said calibration point.

4. The method according to claim **3**, wherein said interaction structure is a rectangle, and wherein a side of said interaction structure has a predetermined relation to a device used to measure the orientation and position of the pointing device.

5. A method for controlling a parameter related to position of a cursor on a projected computer screen image, comprising:

measuring an angle between a pointing line and a first line, said first line being related in a predetermined way to at least one of Earth's magnetic field direction and Earth's gravity field direction, and said pointing line having a predetermined relation to a pointing device;

using a parameter related to the measured angle to control the parameter of said cursor on said computer screen image.

6. The method of claim **5**, further comprising:

first measuring the angle between said pointing line and said first line, said pointing line having a predetermined relation to a point-of-aim;

establishing a calibration point, said calibration point having a predetermined relation to said computer screen image;

directing said pointing line to substantially pass through said calibration point while second measuring the angle between said pointing line and said first line;

using the first measured angle and the second measured angle to constrain a parameter related to said point-of-aim whereby the cursor parameter is controlled by position of said point-of-aim measured relative to said projected computer screen image.

7. A method for controlling a computer display cursor in an interaction region, comprising:

establishing a calibration point having a predetermined relation to said interaction region;

first measuring at least one of a position and orientation of a pointing line while directing said pointing line to substantially pass through said calibration point, the first measurement used to constrain a parameter of said calibration point, the pointing line having a predetermined relationship to at least one of position and orientation of a pointing device;

using a characteristic feature of said interaction region to establish a property of a common point of said pointing line and said interaction region measured relative to said interaction region;

measuring at least one of position and orientation of the pointing device; and

using the characteristic feature of said interaction region and measurement of the pointing device to control the cursor on a computer display image.

8. The method of claim **7**, further comprising constraining a coordinate of a point-of-aim of said pointing device, measured relative to said interaction region, said point-of-aim substantially lying on said pointing line, the constraining comprising:

second measuring the at least one of a position of a point of and an orientation of said pointing line and using the second measurement of said pointing line and the first measurement of said pointing line to constrain the coordinate of said point-of-aim, whereby said first measurement is used to constrain the coordinate of said point-of-aim relative to said interaction region.

9. The method according to claim **8**, further comprising:

initializing said interaction region to have a predetermined relationship with a predetermined interaction structure; and

formulating a description of said interaction structure, whereby said description is used to constrain a parameter of said point-of-aim relative to said interaction region.

10. The method according to claim **9**, further comprising:

combining said description of said interaction structure with the first measurement of said pointing line and said second measurement of said pointing line to constrain a coordinate of an intersection point of said pointing line and said interaction structure during said second measurement.

11. The method according to claim **10**, further comprising controlling said cursor on said computer display image based on the relation between said intersection point and said description of said interaction structure.

12. A method for controlling a parameter related to position of a cursor on a computer screen image, comprising:

measuring a first angle between a pointing line and a first line;

measuring a second angle between said pointing line and a second line, said first line being related in a predetermined way to a geographic reference, said second line being related in a predetermined way to a geographic reference, said pointing line having a predetermined relation to said pointing device, and

using a first parameter related to the first angle, and a second parameter related to the second angle to control the parameter of said cursor on said computer screen image,

whereby said cursor position parameter is controlled by movement of said pointing device.

13. The method of claim **12**, further comprising constraining a parameter of a point-of-aim of said pointing device with respect to an interaction region, the constraining comprising:

first measuring the first angle and the second angle wherein said pointing line has a predetermined relation to said point-of-aim;

establishing a calibration point having a predetermined relation to said interaction region;

second measuring the first angle and the second angle while directing said pointing line to substantially pass through said calibration point; and

using the first measurement and the second measurement of said first and second angles to constrain the coordinate of said point-of-aim, whereby the parameter of said cursor on said computer screen image is controlled by the parameter of said point-of-aim measured relative to said interaction region.

14. The method of claim **12** wherein the geographic reference for the first line is one of Earth's magnetic field direction and Earth's gravity field direction, and the geographic reference for the second line is one of Earth's magnetic field direction and Earth's gravity field direction.

15. A pointing device for controlling a feature on an image generated by a computer, comprising:

a handheld enclosure having a predetermined relation to a pointing line;

a sensing device for generating first data indicative of a first spatial state of said enclosure while the pointing line is directed at a first calibration point, said first calibration point having a predetermined relation to the image, and for generating second data indicative of a second spatial state of said enclosure while the pointing line is directed at a non-calibration point on the image; and

a communication element coupled to said sensing device for providing control data to the computer for controlling the feature on the image, said control data being based on said first data and said second data,

wherein the feature on the image can be controlled based on the relation between the first spatial state and the second spatial state of said enclosure.

16. The pointing device according to claim **15**, wherein said sensing device generates third data indicative of a third spatial state of said enclosure while the pointing line is directed at a second calibration point, said second calibration point having a predetermined relation to the computer image,

wherein said control data is further based on said third data, and

wherein the feature on the image can be further controlled based on the relation between the third spatial state and the second spatial state and the first spatial state of said enclosure.

17. The pointing device according to claim **16**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

18. The pointing device according to claim **16**, wherein said first spatial state, said second spatial state and said third spatial state comprise an orientation of said enclosure.

19. The pointing device according to claim **15**, wherein said sensing device includes an accelerometer.

20. The pointing device according to claim **19**, wherein said first spatial state and said second spatial state comprise an orientation of said enclosure.

21. The pointing device according to claim **15**, wherein said sensing device includes a gravity sensor.

22. The pointing device according to claim **15**, wherein said sensing device includes a magnetic field sensor.

23. The pointing device according to claim **15**, wherein said sensing device includes a gyroscope.

24. The pointing device according to claim **23**, wherein said first spatial state and said second spatial state comprise an orientation of said enclosure.

25. The pointing device according to claim **15**, wherein said sensing device includes an image sensor.

26. The pointing device according to claim **15**, wherein said sensing device includes an inclinometer.

27. An apparatus for determining a spatial relation between a computer generated image and a user-wielded pointing device, comprising:

a sensing device for generating first calibration data indicative of a first spatial state of the pointing device, said sensing device being at least partly contained in the pointing device;

a user input device to indicate that the pointing device is located at a first position and directed towards a first point, said first point having a predetermined relation to the image; and

a processor coupled to said sensing device and said user input device and programmed to use said first calibration data to determine the spatial relation between the image and the pointing device located at said first position,

wherein the spatial relation is provided to control a feature on the image.

28. The apparatus of claim **27**, wherein said sensing device generates second calibration data indicative of a second spatial state of the pointing device,

wherein said user input device further indicates that the pointing device is substantially located at the first position and directed towards a second point, said second point having a predetermined relation to the image, and

wherein said processor further uses said second calibration data in determining the spatial relation between the image and the pointing device located at said first position.

29. The apparatus of claim **28**, wherein said sensing device generates third and fourth calibration data indicative of third and fourth spatial states of the pointing device,

wherein said user input device further indicates that the pointing device is substantially located at the first position and directed towards third and fourth points, said third and fourth points each having a predetermined relation to the image, and

wherein said processor further uses said third and fourth calibration data in determining the spatial relation between the image and the pointing device located at said first position.

30. The apparatus of claim **28**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

31. The apparatus of claim **27**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

32. The apparatus of claim **27**, wherein said sensing device generates second calibration data indicative of a second spatial state of the pointing device,

wherein said user input device further indicates that the pointing device is substantially located at a second position and directed towards a second point, said second point having a predetermined relation to the image, and

wherein said processor further uses said second calibration data in determining the spatial relation between the image and the pointing device.

33. An apparatus for controlling a feature on an image generated by a computer, comprising:

a handheld enclosure including a sensing device which provides data;

a user input device to indicate that said enclosure is being directed towards a first calibration point, said first calibration point having a predetermined relation to the image; and

a processor coupled to said sensing device and said user input device and programmed to provide control data for controlling the feature on the image, said processor using data provided by said sensing device to develop first calibration data related to said enclosure being directed towards said first calibration point and non-calibration data related to said enclosure being directed towards a non-calibration point, said processor further using said first calibration data and said non-calibration data to develop said control data.

34. The apparatus according to claim **33**, wherein said user input device further indicates that said enclosure is being directed towards a second calibration point, said second calibration point having a predetermined relation to the image; and

wherein said processor further uses data provided by said sensing device to develop second calibration data related to said enclosure being directed towards said second calibration point, with said second calibration data being further used to develop said control data.

35. The apparatus according to claim **34**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

36. The apparatus according to claim **33**, wherein said sensing device includes an imaging device,

wherein said user input device further indicates that said enclosure is directed at third and fourth calibration points, said third and fourth calibration points having a predetermined relation to the image; and

wherein said processor further uses data provided by said sensing device to develop third and fourth calibration data related to said enclosure being directed at said third and fourth calibration points, with said third and fourth calibration data being further used to develop said control data.

37. The apparatus according to claim **33**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

38. The apparatus according to claim **33**, wherein said first calibration data is used to determine a spatial relation between said enclosure and the image, and wherein said spatial relation and said non-calibration data are used to develop said control data.

39. The apparatus according to claim **33**, further comprising:

a distance determining device coupled to said processor for determining distance between said enclosure and a target point in a plane substantially containing the image,

wherein said processor uses said distance in developing said control data, and

wherein the controlling a feature on the image comprises a zoom event.

40. An apparatus for controlling a feature on an image generated by a computer, comprising:

a handheld enclosure including a sensing device which provides data;

a user input device for collecting first calibration data indicating that said enclosure is directed towards a first calibration point, said first calibration point having a predetermined relation to the image; and

a processor coupled to said sensing device and said user input device and programmed to provide control data for controlling the feature on the image, said processor using said first calibration data and data provided by said sensing device while the enclosure is being directed at other than said first calibration point to develop said control data.

41. The apparatus according to claim **40**, wherein said user input device further collects second calibration data indicating that said enclosure is directed towards a second calibration point, said second calibration point having a predetermined relation to the image; and

wherein said processor further uses said second calibration data in the developing said control data.

42. The apparatus according to claim **41**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

43. The apparatus according to claim **40**, wherein said sensing device includes at least one of an accelerometer, a gravity sensor, a magnetic field sensor, a gyroscope, an image sensor and an inclinometer.

44. A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld enclosure which has a pointing line having a predetermined relation with the enclosure and a sensing device which provides sensor data, the method comprising:

determining a first spatial state of the enclosure while the pointing line is directed at a first calibration point, said first calibration point having a predetermined relation to the image, based on received sensor data;

determining a second spatial state of the enclosure while the pointing line is directed at a non-calibration point on the image based on received sensor data; and

controlling the feature on the image based on the relation between the first spatial state and the second spatial state of the enclosure.

45. The computer-readable medium or media of claim **44**, the method further comprising:

determining a third spatial state of the enclosure while the pointing line is directed at a second calibration point, said second calibration point having a predetermined relation to the computer image, based on received sensor data,

wherein the feature on the image is further controlled based on the relation between the first, second and third spatial states of the enclosure.

46. The computer-readable medium or media of claim **44**, wherein said first spatial state and said second spatial state comprise an orientation of the enclosure.

47. A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld pointing device which has a sensing device which provides sensor data and a user input device to indicate that the pointing device is directed at a point, the method comprising:

determining a first spatial state of the pointing device based on received sensor data when the user input device indicates that the pointing device is located at a first position and directed towards a first point, said first point having a predetermined relation to the image; and

determining the spatial relation between the image and the pointing device located at said first position based on the first spatial state; and

controlling the feature on the image based on the first spatial state and the spatial relation.

48. The computer-readable medium or media of claim **47**, the method further comprising:

determining a second spatial state of the pointing device when the user input device indicates that the pointing device is substantially located at the first position and directed towards a second point, said second point having a predetermined relation to the image,

wherein determining the spatial relation between the image and the pointing device located at said first position is further based on said second spatial state.

49. The computer-readable medium or media of claim **48**, the method further comprising:

determining third and fourth spatial states of the pointing device when the user input device further indicates that the pointing device is substantially located at the first position and directed towards third and fourth points, said third and fourth points each having a predetermined relation to the image, and

wherein determining the spatial relation between the image and the pointing device located at said first position is further based on said third and fourth spatial states.

50. The computer-readable medium or media of claim **47**, the method further comprising:

determining a second spatial state of the pointing device when the user input device indicates that the pointing device is substantially located at a second position and directed towards a second point, said second point having a predetermined relation to the image,

wherein determining the spatial relation between the image and the pointing device is further based on said second spatial state.

51. A computer-readable medium or media storing computer-executable instructions for directing a computer to perform a method for controlling a feature on an image generated by a computer using a handheld enclosure which has a sensing device which provides sensor data and a user input device to indicate that the pointing device is directed at a point, the method comprising:

determining first calibration data when the user input device indicates that the enclosure is being directed towards a first calibration point, said first calibration point having a predetermined relation to the image, based on received sensor data;

determining non-calibration data when the enclosure is being directed towards a non-calibration point on the image based on received sensor data; and

controlling the feature on the image based on said first calibration data and said non-calibration data.

52. The computer-readable medium or media of claim **51**, the method further comprising:

determining second calibration data when the user input device indicates that the enclosure is being directed towards a second calibration point, said second calibration point having a predetermined relation to the image, based on received sensor data,

wherein controlling the feature on the image is further based on said second calibration data.

53. The computer-readable medium or media of claim **52**, the method further comprising:

determining third and fourth calibration data when the user input device indicates that the enclosure is directed at third and fourth calibration points, said third and fourth calibration points having a predetermined relation to the image, based on received sensor data,

wherein controlling the feature on the image is further based on said third and fourth calibration data related.

* * * * *

US008049729B2

(12) **United States Patent**
Banning

(10) **Patent No.: US 8,049,729 B2**
(45) **Date of Patent: Nov. 1, 2011**

(54) **EASILY DEPLOYABLE INTERACTIVE DIRECT-POINTING SYSTEM AND PRESENTATION CONTROL SYSTEM AND CALIBRATION METHOD THEREFOR**

(76) Inventor: **Erik Jan Banning**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/782,980**

(22) Filed: **May 19, 2010**

(65) **Prior Publication Data**

US 2010/0283732 A1 Nov. 11, 2010

Related U.S. Application Data

(63) Continuation of application No. 11/135,911, filed on May 24, 2005, now Pat. No. 7,746,321.

(60) Provisional application No. 60/575,671, filed on May 28, 2004, provisional application No. 60/644,649, filed on Jan. 18, 2005.

(51) **Int. Cl.**
G09G 5/00 (2006.01)

(52) **U.S. Cl.** **345/169**; 345/157

(58) **Field of Classification Search** 345/156–204; 178/18.03, 19.01
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,349,815 A 9/1982 Spooner
4,562,433 A 12/1985 Biferno
4,565,999 A 1/1986 King et al.
4,567,479 A 1/1986 Boyd
4,641,255 A 2/1987 Hohmann
4,654,648 A 3/1987 Herrington et al.
4,682,159 A 7/1987 Davison
4,682,195 A 7/1987 Yilmaz
4,730,186 A 3/1988 Koga et al.
4,745,402 A 5/1988 Auerbach
4,768,028 A 8/1988 Blackie
4,787,051 A 11/1988 Olson
4,796,019 A 1/1989 Auerbach
4,823,170 A 4/1989 Hansen
4,959,721 A 9/1990 Micic et al.
5,009,501 A 4/1991 Fenner et al.
5,023,943 A 6/1991 Heberle
5,045,843 A 9/1991 Hansen
5,047,754 A 9/1991 Akatsuka et al.
5,095,302 A 3/1992 McLean et al.
5,231,674 A 7/1993 Cleveland et al.
5,235,363 A 8/1993 Vogeley et al.

(Continued)

OTHER PUBLICATIONS

Mark Ashdown, Peter Robinson; The Escritoire: A Personal Projected Display for Interacting With Documents; Technical Report; No. 538; University of Cambridge Computer Laboratory; Jun. 2002; UCAM-CL-TR-538; ISSN 1476-2986.

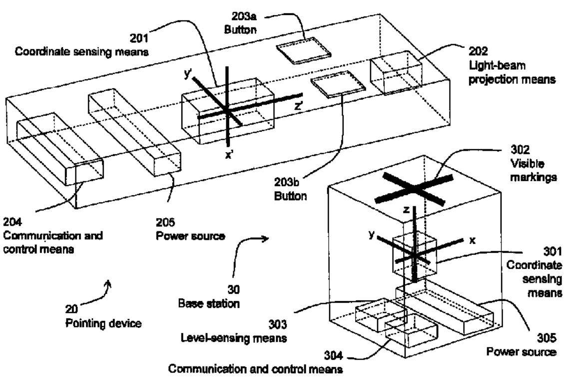
(Continued)

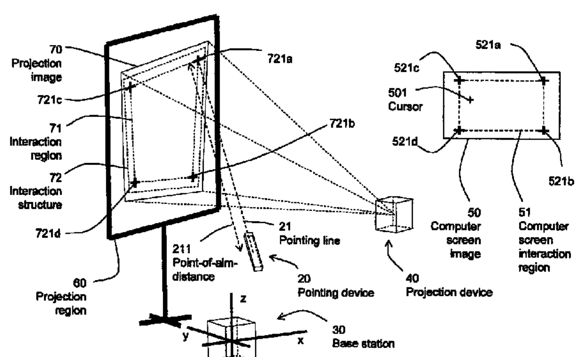
Primary Examiner — Nitin Patel
(74) *Attorney, Agent, or Firm* — Wong, Cabello, Lutsch, Rutherford & Brucculeri, LLP

(57) **ABSTRACT**

A method for controlling movement of a computer display cursor based on a point-of-aim of a pointing device within an interaction region includes projecting an image of a computer display to create the interaction region. At least one calibration point having a predetermined relation to said interaction region is established. A pointing line is directed to substantially pass through the calibration point while measuring a position of and an orientation of the pointing device. The pointing line has a predetermined relationship to said pointing device. Movement of the cursor is controlled within the interaction region using measurements of the position of and the orientation of the pointing device.

14 Claims, 20 Drawing Sheets





U.S. PATENT DOCUMENTS

5,262,777	A	11/1993	Low et al.	
5,274,363	A	12/1993	Koved et al.	
5,296,838	A	3/1994	Suzuki	
5,339,095	A	8/1994	Redford	
5,359,348	A	10/1994	Pilcher et al.	
5,367,315	A	11/1994	Pan	
5,394,360	A	2/1995	Fukumoto	
5,448,261	A	9/1995	Koike et al.	
5,469,193	A	11/1995	Giobbi et al.	
5,484,966	A	1/1996	Segen	
5,502,459	A	3/1996	Marshall et al.	
5,506,605	A	4/1996	Paley	
5,602,568	A	2/1997	Kim	
5,631,669	A	5/1997	Stobbs et al.	
5,638,092	A	6/1997	Eng et al.	
5,654,741	A	8/1997	Sampsell et al.	
5,668,574	A	9/1997	Jarlance-Huang	
5,734,371	A	3/1998	Kaplan	
5,793,354	A	8/1998	Kaplan	
5,796,386	A	8/1998	Lipscomb et al.	
5,883,616	A	3/1999	Koizumi et al.	
5,898,421	A	4/1999	Quinn	
5,898,424	A	4/1999	Flannery	
5,926,168	A *	7/1999	Fan	345/158
5,929,444	A	7/1999	Leichner	
5,952,996	A	9/1999	Kim et al.	
5,963,134	A	10/1999	Bowers et al.	
5,999,167	A	12/1999	Marsh et al.	
6,037,943	A	3/2000	Crone et al.	
6,067,085	A	5/2000	Modh et al.	
6,069,594	A	5/2000	Barnes et al.	
6,084,556	A	7/2000	Zwern	
6,104,380	A	8/2000	Stork et al.	
6,104,390	A	8/2000	Sturgeon et al.	
6,130,663	A	10/2000	Null	
6,130,664	A	10/2000	Suzuki	
6,171,190	B1	1/2001	Thanasack et al.	
6,184,863	B1	2/2001	Sibert et al.	
6,186,630	B1	2/2001	Miyashita	
6,212,296	B1	4/2001	Stork et al.	
6,271,831	B1	8/2001	Escobosa et al.	
6,275,214	B1	8/2001	Hansen	
6,292,171	B1 *	9/2001	Fu et al.	345/156
6,297,804	B1	10/2001	Kashitani	
6,326,979	B1	12/2001	Radeztsky	
6,335,723	B1	1/2002	Wood et al.	
6,342,878	B1	1/2002	Chevassus et al.	
6,373,961	B1	4/2002	Richardson et al.	
6,385,331	B2	5/2002	Harakawa et al.	
6,388,656	B1	5/2002	Chae	
6,400,139	B1	6/2002	Khalfin et al.	
6,404,416	B1	6/2002	Kahn et al.	
6,411,277	B1	6/2002	Shah-Nazaroff	
6,417,840	B1	7/2002	Daniels	
6,424,340	B1	7/2002	Holtzman et al.	
6,452,606	B1	9/2002	Luzzatto	
6,483,499	B1	11/2002	Li et al.	
6,492,981	B1	12/2002	Stork et al.	
6,504,526	B1	1/2003	Mauritz	
6,507,339	B1	1/2003	Tanaka	
6,520,647	B2	2/2003	Raskar	
6,529,186	B1	3/2003	Thayer	
6,545,661	B1	4/2003	Goschy et al.	
6,545,664	B1	4/2003	Kim	
6,558,002	B1	5/2003	Miyashita	
6,559,833	B2	5/2003	Rowe	
6,567,071	B1	5/2003	Curran et al.	
6,600,478	B2	7/2003	White et al.	
6,606,083	B1	8/2003	Murray et al.	
6,608,668	B2	8/2003	Gharib et al.	
6,642,918	B2	11/2003	Uchida et al.	
6,795,068	B1	9/2004	Marks	
6,877,863	B2	4/2005	Wood et al.	
7,075,514	B2	7/2006	Tanaka	
7,158,117	B2 *	1/2007	Sato et al.	345/158
7,158,118	B2	1/2007	Liberty	
7,239,301	B2	7/2007	Liberty et al.	
7,262,760	B2	8/2007	Liberty	
7,414,611	B2	8/2008	Liberty	
7,489,298	B2	2/2009	Liberty et al.	
7,746,321	B2 *	6/2010	Banning	345/157
2001/0010514	A1	8/2001	Ishino	
2001/0043719	A1	11/2001	Harakawa et al.	
2002/0042699	A1	4/2002	Tanaka et al.	
2002/0075386	A1	6/2002	Tanaka	
2002/0079143	A1	6/2002	Silverstein et al.	
2002/0084980	A1	7/2002	White et al.	
2002/0085097	A1	7/2002	Colmenarez et al.	
2002/0089489	A1	7/2002	Carpenter	
2003/0030622	A1	2/2003	Vaarala	
2004/0070564	A1	4/2004	Dawson	
2004/0233461	A1	11/2004	Armstrong et al.	
2005/0093823	A1	5/2005	Hinckley et al.	
2005/0270494	A1	12/2005	Banning	
2007/0060383	A1	3/2007	Dohta	
2007/0066394	A1	3/2007	Ikeda et al.	
2007/0298882	A1	12/2007	Marks et al.	

OTHER PUBLICATIONS

Ronald Azuma, Bruce Hoff, Howard Neely III, Ron Sarfaty, "A Motion-Stabilized Outdoor Augmented Reality System," Proceedings of IEEE Virtual Reality '99 (Houston, TX, Mar. 13-17, 1999), p. 252-259.

Mark Ashdown, Peter Robinson, "The Writing's on the Wall: Large, Remotely Controlled Displays", Proceedings of the First European Conference on Computer-Supported Collaborative Learning, Mar. 22-24, 2001,p. 83-88.

Pierre David Wellner, "Interacting with paper on the DigitalDesk", http://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-330.html, Mar. 1994, p. 1-107.

Office Action in U.S. Appl. No. 11/483,170, dated Apr. 25, 2011, including search information, pp. 1-46.

* cited by examiner

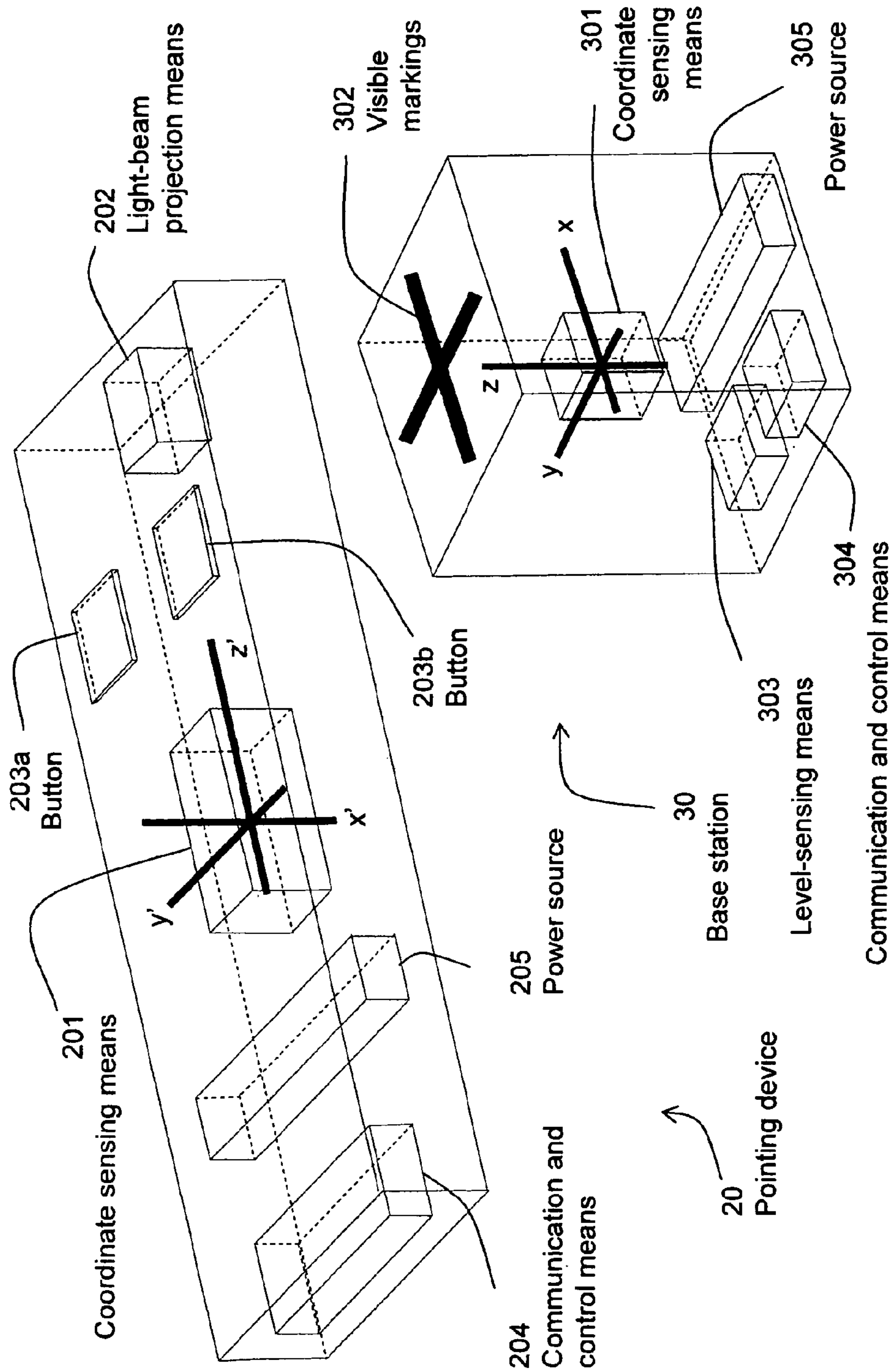

202
Light-beam
projection means
302
Visible
markings
301
Coordinate
sensing
means
305
Power source
x
z
y
304
Communication and control means
303
Level-sensing means
30
Base station
203b
Button
203a
Button
z'
x'
y'
201
Coordinate sensing means
205
Power source
20
Pointing device
204
Communication and
control means

Fig. 1

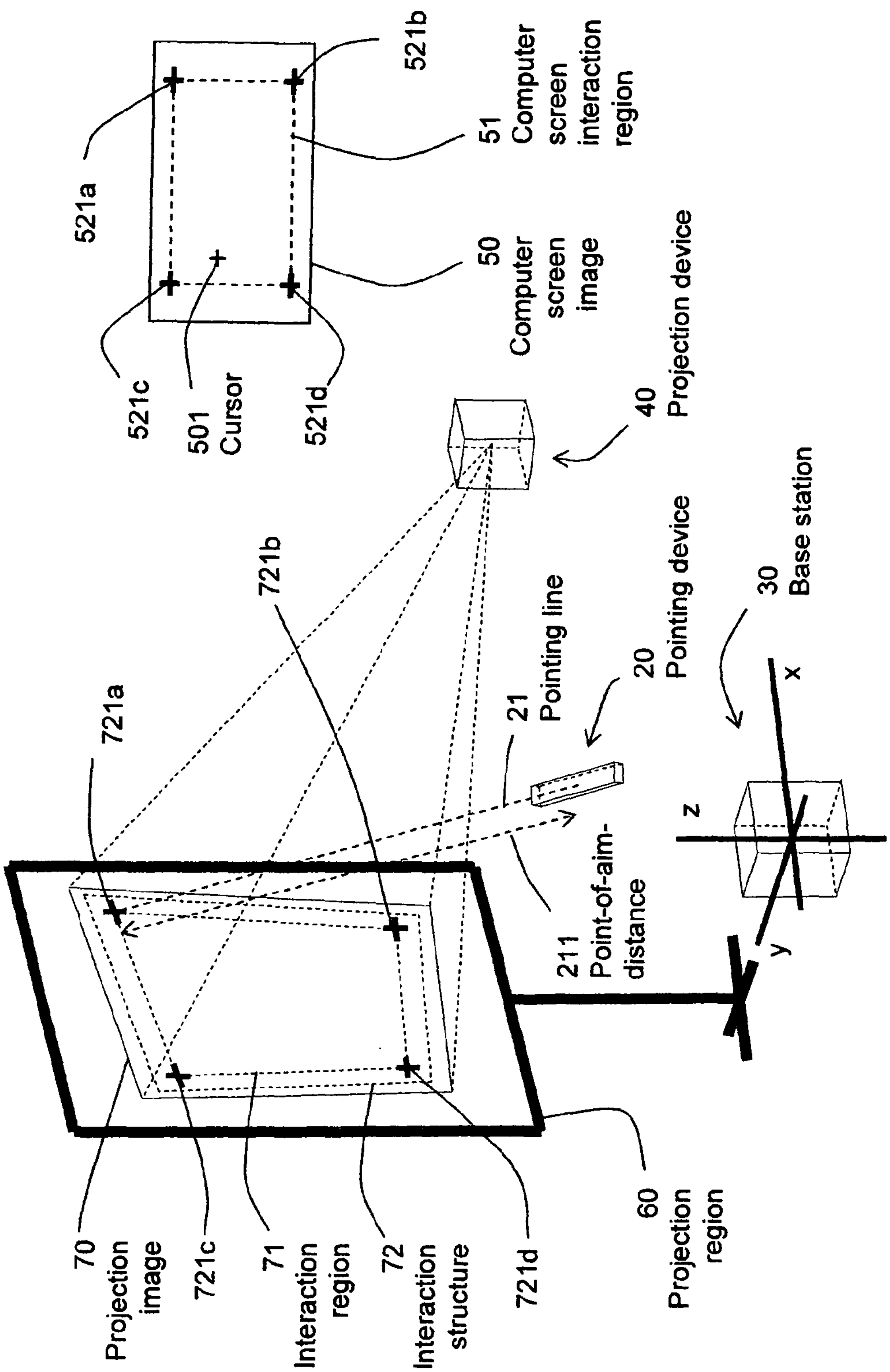

521a
521b
51 Computer screen interaction region
521c
501 Cursor
521d
50 Computer screen image
40 Projection device
721a
721b
21 Pointing line
20 Pointing device
30 Base station
x
z
y
211 Point-of-aim-distance
70 Projection image
721c
71 Interaction region
72 Interaction structure
721d
60 Projection region

Fig. 2

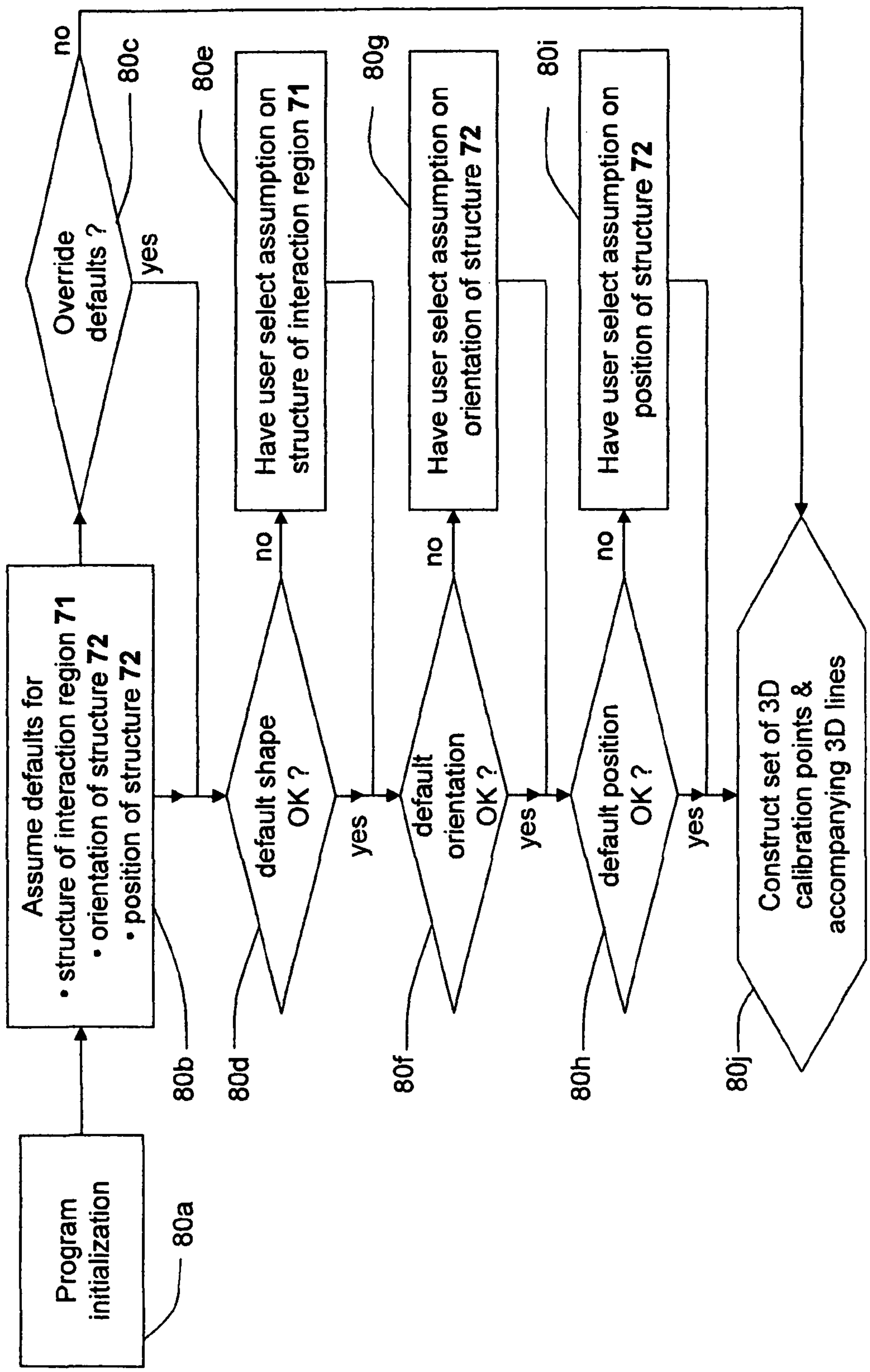
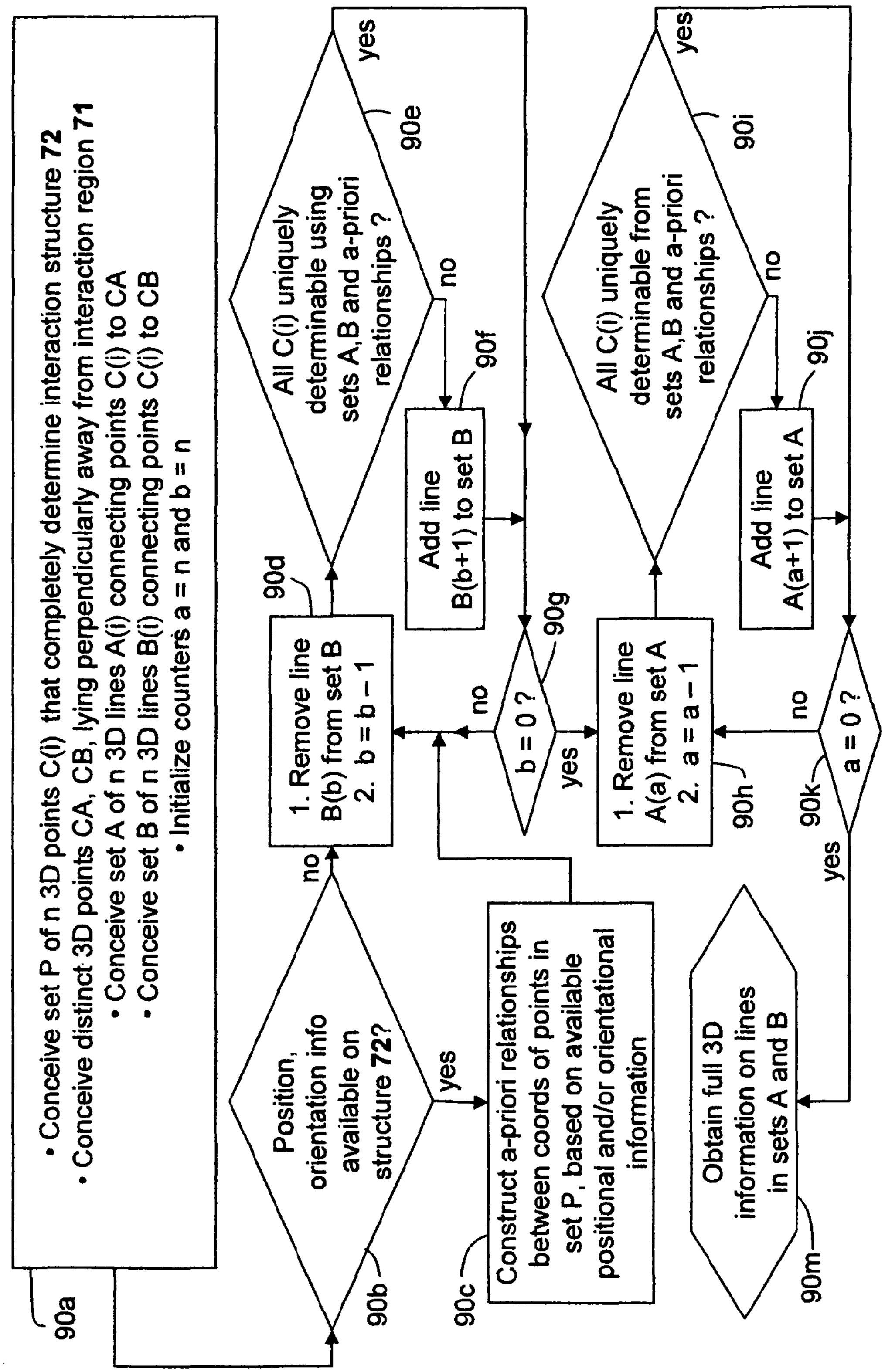

Program initialization
80a
Assume defaults for
• structure of interaction region 71
• orientation of structure 72
• position of structure 72
80b
Override defaults ?
80c
no
yes
default shape OK ?
80d
no
yes
Have user select assumption on structure of interaction region 71
80e
default orientation OK ?
80f
no
yes
Have user select assumption on orientation of structure 72
80g
default position OK ?
80h
no
yes
Have user select assumption on position of structure 72
80i
Construct set of 3D calibration points & accompanying 3D lines
80j

Fig. 3



• Conceive set P of n 3D points C(i) that completely determine interaction structure 72
• Conceive distinct 3D points CA, CB, lying perpendicularly away from interaction region 71
• Conceive set A of n 3D lines A(i) connecting points C(i) to CA
• Conceive set B of n 3D lines B(i) connecting points C(i) to CB
• Initialize counters a = n and b = n
90a
Position, orientation info available on structure 72?
90b
yes
no
Construct a-priori relationships between coords of points in set P, based on available positional and/or orientational information
90c
1. Remove line B(b) from set B
2. b = b – 1
90d
All C(i) uniquely determinable using sets A,B and a-priori relationships ?
90e
yes
no
Add line B(b+1) to set B
90f
b = 0 ?
90g
no
yes
1. Remove line A(a) from set A
2. a = a – 1
90h
All C(i) uniquely determinable from sets A,B and a-priori relationships ?
90i
yes
no
Add line A(a+1) to set A
90j
a = 0 ?
90k
no
yes
Obtain full 3D information on lines in sets A and B
90m

Fig. 4

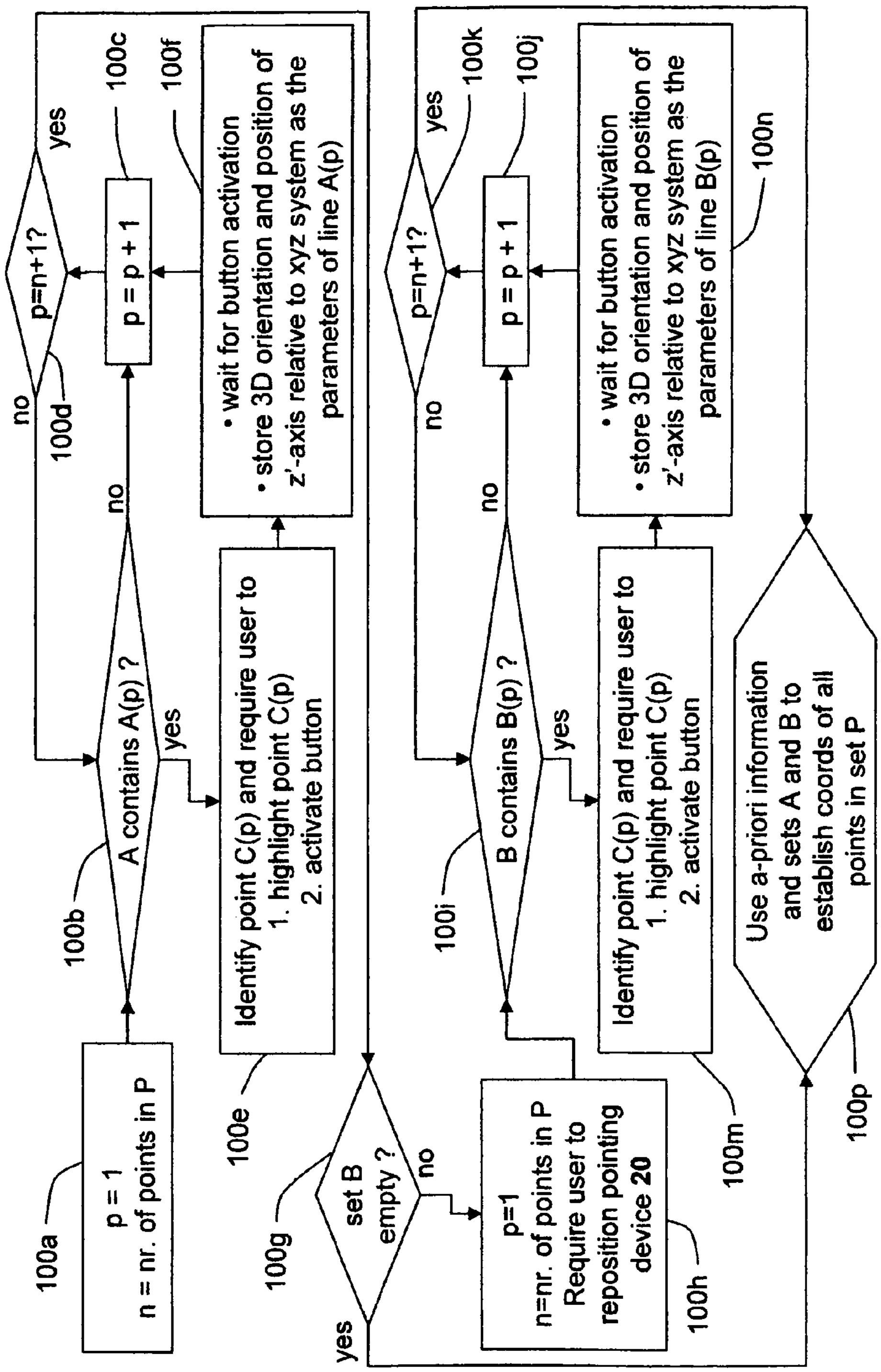

100a
p = 1
n = nr. of points in P
100b
A contains A(p) ?
yes
no
100c
p = p + 1
100d
p=n+1?
yes
no
100e
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
100f
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p)
100g
set B empty ?
yes
no
100h
p=1
n=nr. of points in P
Require user to reposition pointing device **20**
100i
B contains B(p) ?
yes
no
100j
p = p + 1
100k
p=n+1?
yes
no
100m
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
100n
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line B(p)
100p
Use a-priori information and sets A and B to establish coords of all points in set P

Fig. 5

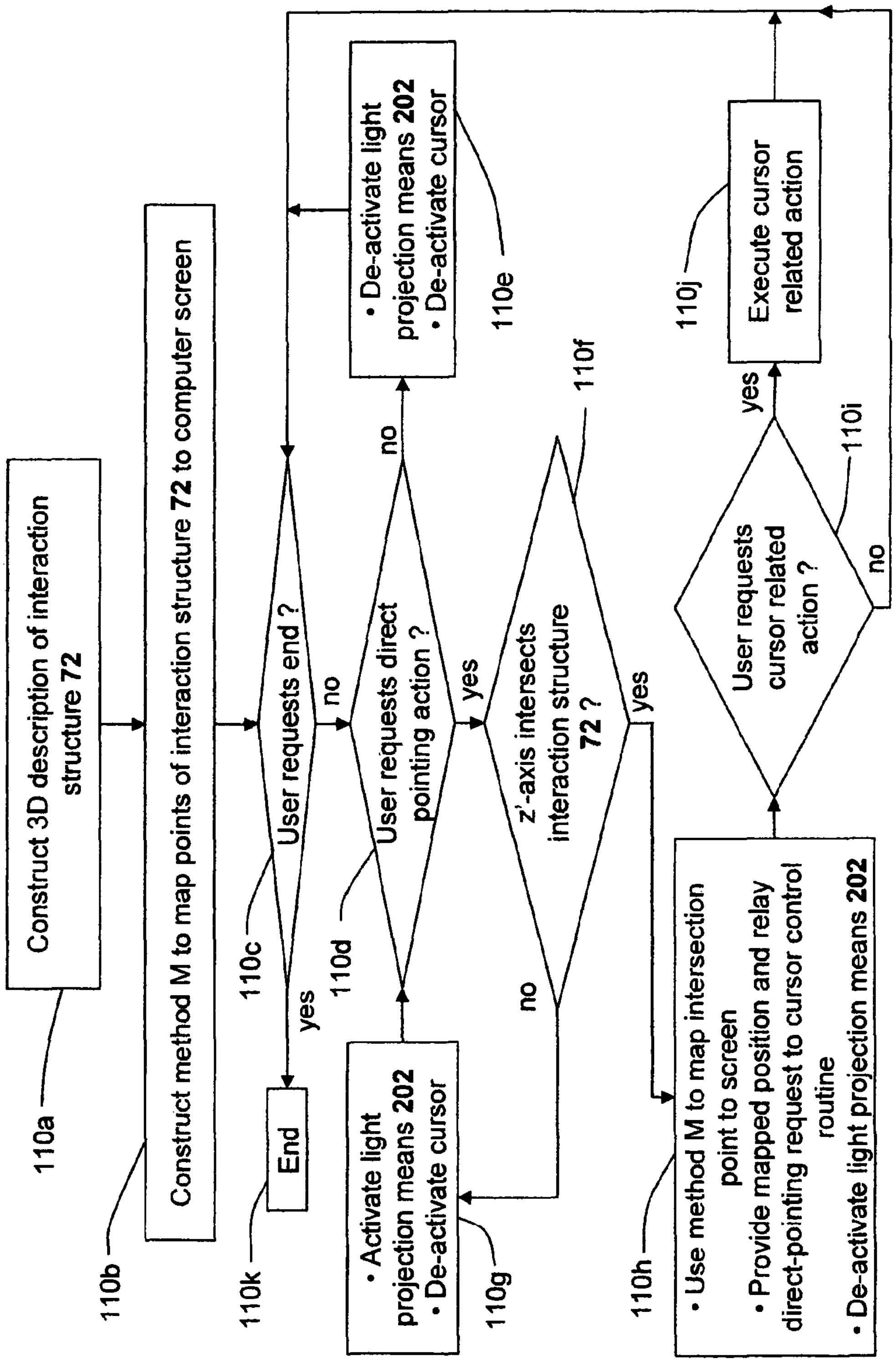

Construct 3D description of interaction structure 72
110a
Construct method M to map points of interaction structure 72 to computer screen
110b
User requests end ?
110c
yes
End
110k
no
User requests direct pointing action ?
110d
no
• De-activate light projection means 202
• De-activate cursor
110e
yes
z'-axis intersects interaction structure 72 ?
110f
no
• Activate light projection means 202
• De-activate cursor
110g
yes
• Use method M to map intersection point to screen
• Provide mapped position and relay direct-pointing request to cursor control routine
• De-activate light projection means 202
110h
User requests cursor related action ?
110i
yes
Execute cursor related action
110j
no

Fig. 6

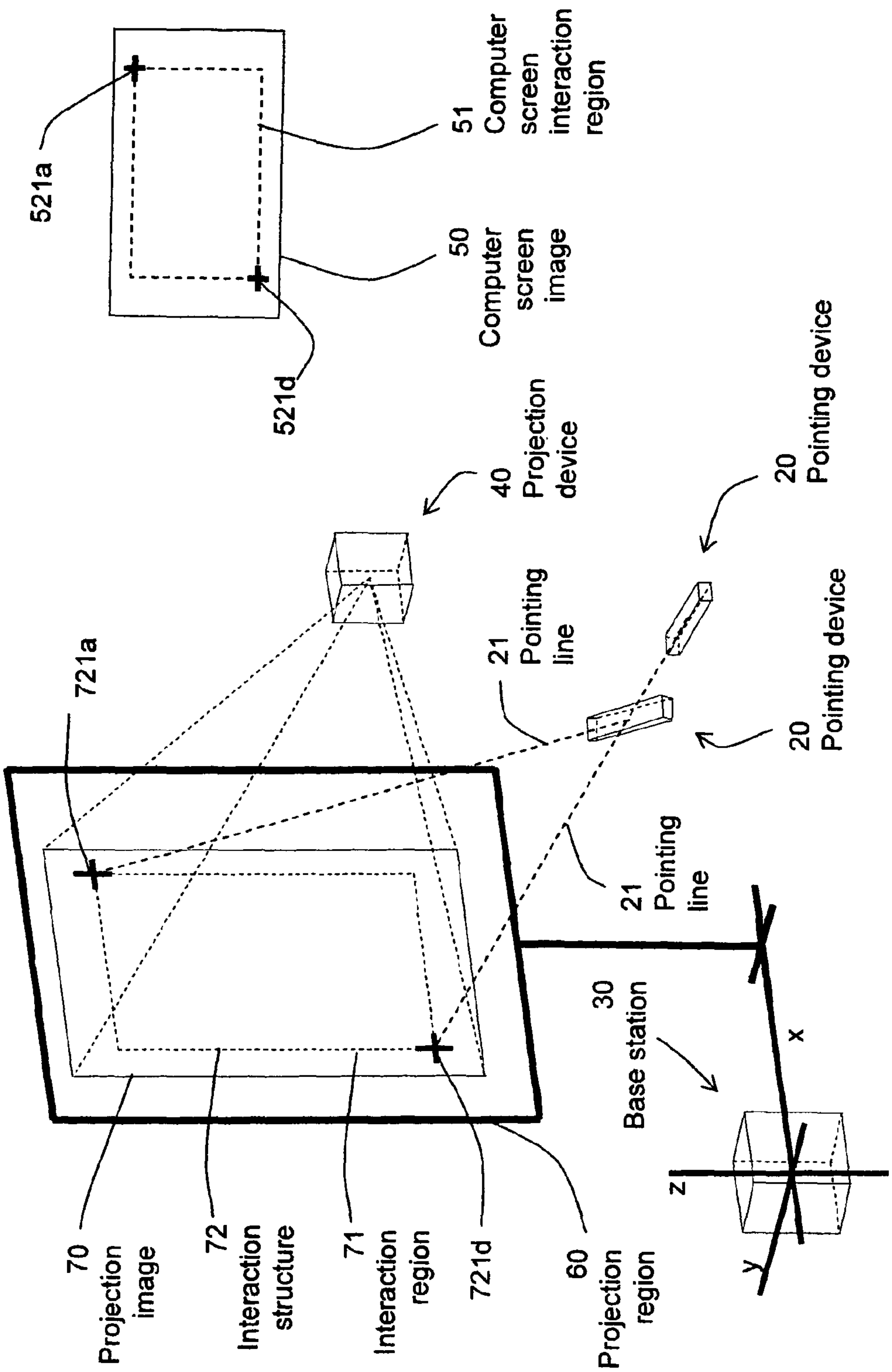

521a
51 Computer screen interaction region
50 Computer screen image
521d
40 Projection device
20 Pointing device
21 Pointing line
20 Pointing device
721a
21 Pointing line
30 Base station
x
z
y
70 Projection image
72 Interaction structure
71 Interaction region
721d
60 Projection region

Fig. 7

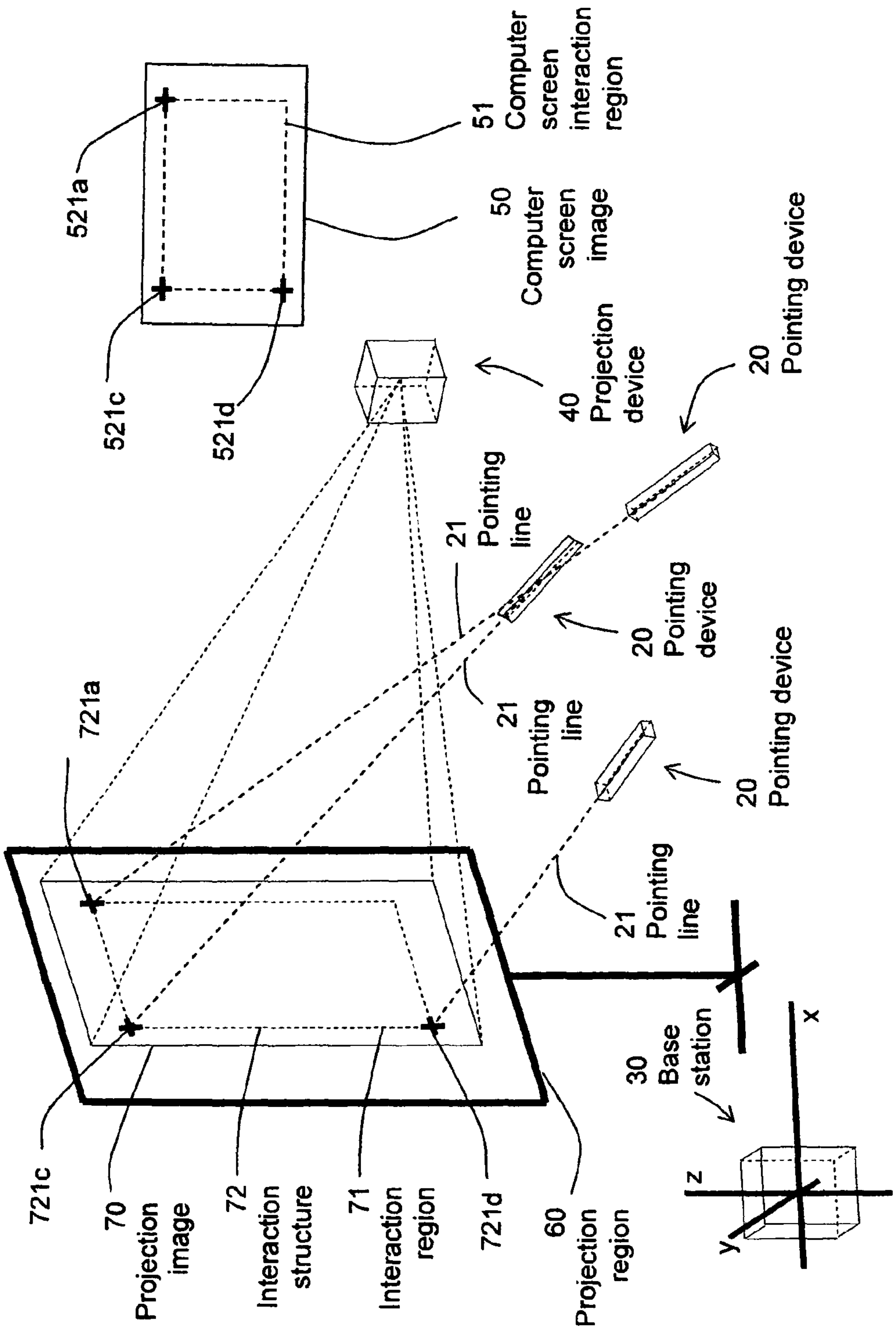

521a
51 Computer screen interaction region
50 Computer screen image
521c
521d
40 Projection device
20 Pointing device
21 Pointing line
20 Pointing device
21 Pointing line
20 Pointing device
21 Pointing line
721a
721c
70 Projection image
72 Interaction structure
71 Interaction region
721d
60 Projection region
30 Base station
x
y
z

Fig. 8

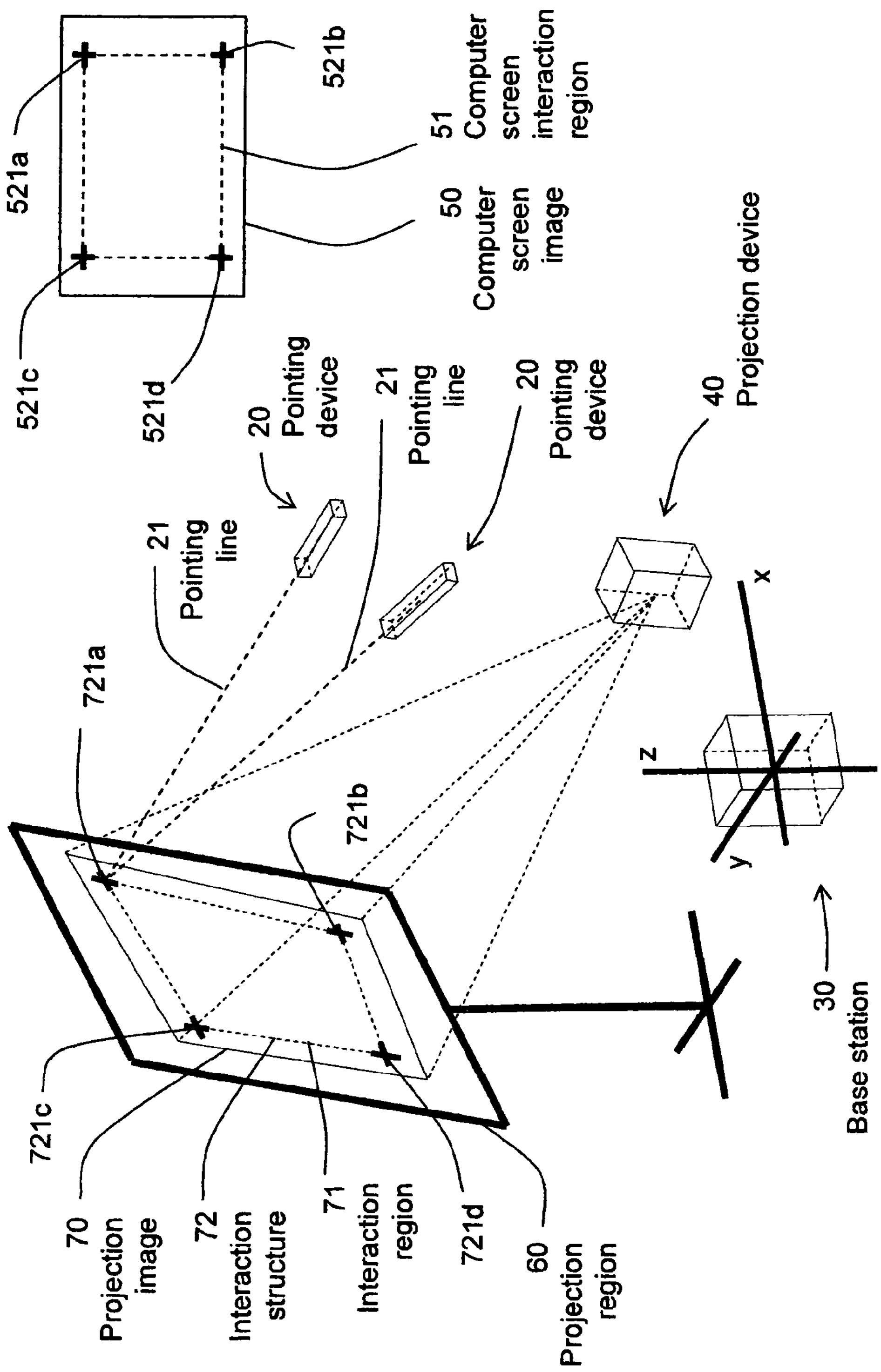
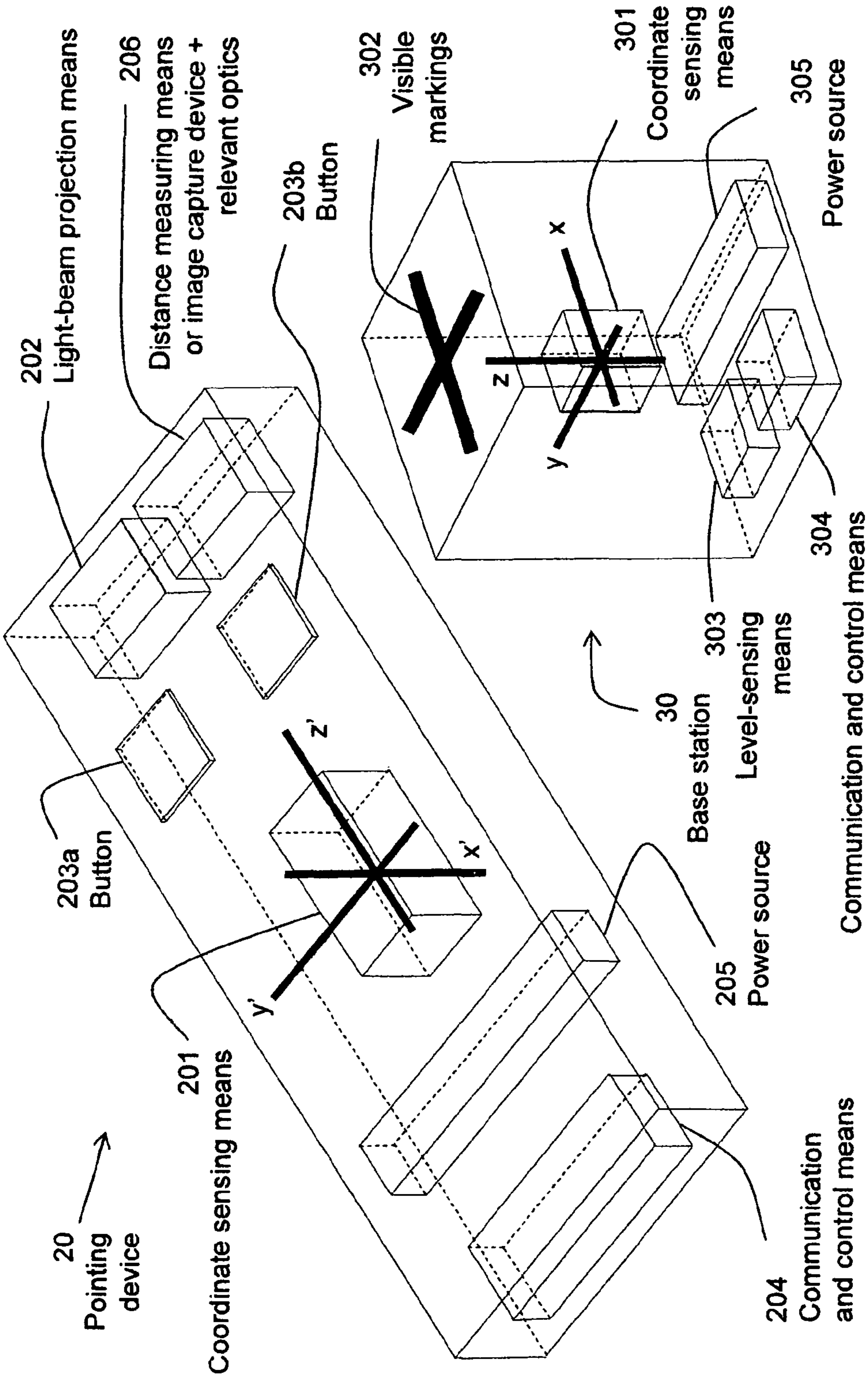
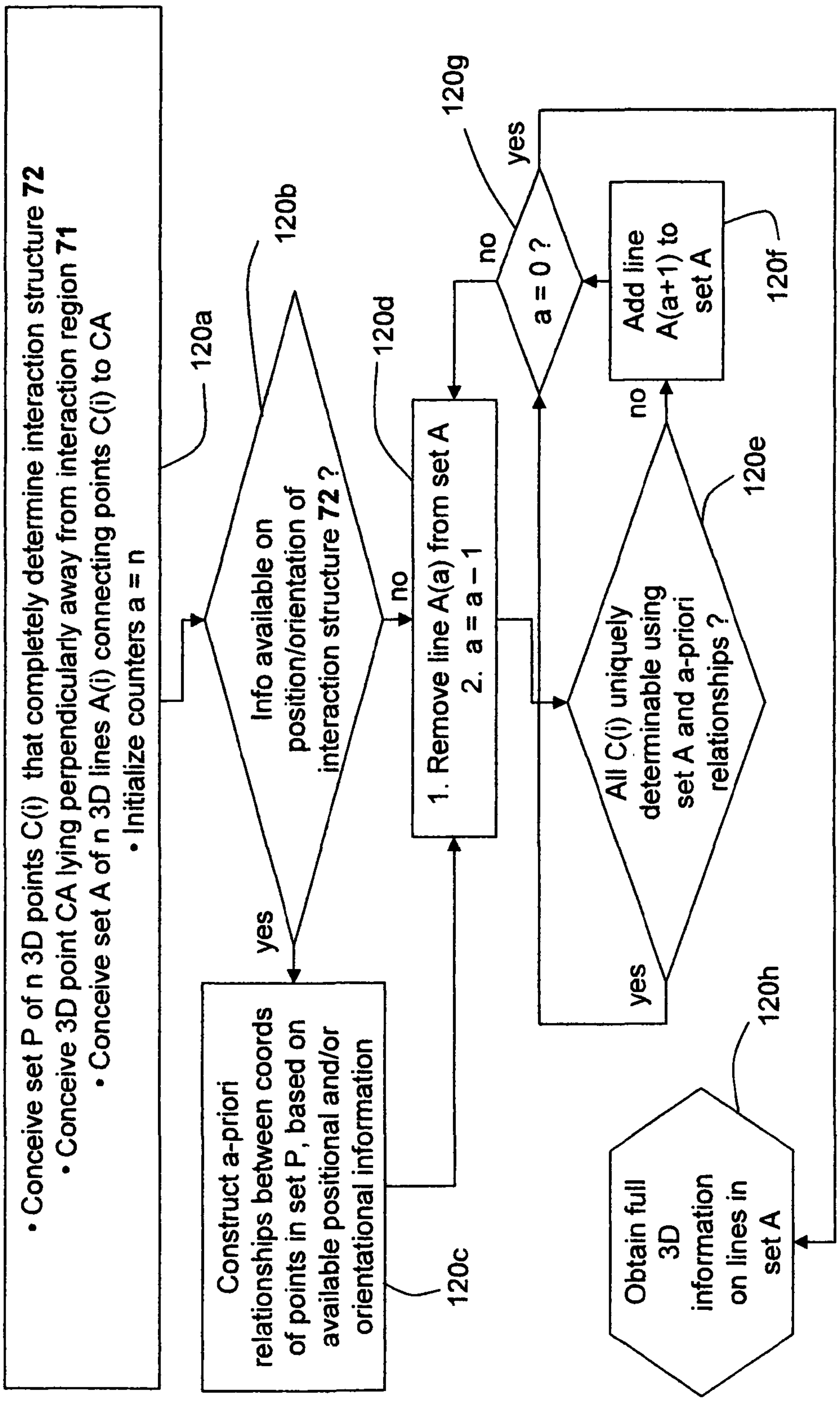

521a
521b
521c
521d
51 Computer screen interaction region
50 Computer screen image
20 Pointing device
21 Pointing line
20 Pointing device
21 Pointing line
40 Projection device
721a
721b
721c
721d
x
y
z
70 Projection image
72 Interaction structure
71 Interaction region
60 Projection region
30 Base station

Fig. 9



20
Pointing device
201
Coordinate sensing means
202
Light-beam projection means
203a
Button
203b
Button
204
Communication and control means
205
Power source
206
Distance measuring means or image capture device + relevant optics
x'
y'
z'
30
Base station
301
Coordinate sensing means
302
Visible markings
303
Level-sensing means
304
Communication and control means
305
Power source
x
y
z

Fig. 10



• Conceive set P of n 3D points C(i) that completely determine interaction structure 72
• Conceive 3D point CA lying perpendicularly away from interaction region 71
• Conceive set A of n 3D lines A(i) connecting points C(i) to CA
• Initialize counters a = n
120a
Info available on position/orientation of interaction structure 72 ?
120b
yes
no
Construct a-priori relationships between coords of points in set P, based on available positional and/or orientational information
120c
1. Remove line A(a) from set A
2. a = a – 1
120d
All C(i) uniquely determinable using set A and a-priori relationships ?
120e
yes
no
Add line A(a+1) to set A
120f
a = 0 ?
120g
no
yes
Obtain full 3D information on lines in set A
120h

Fig. 11

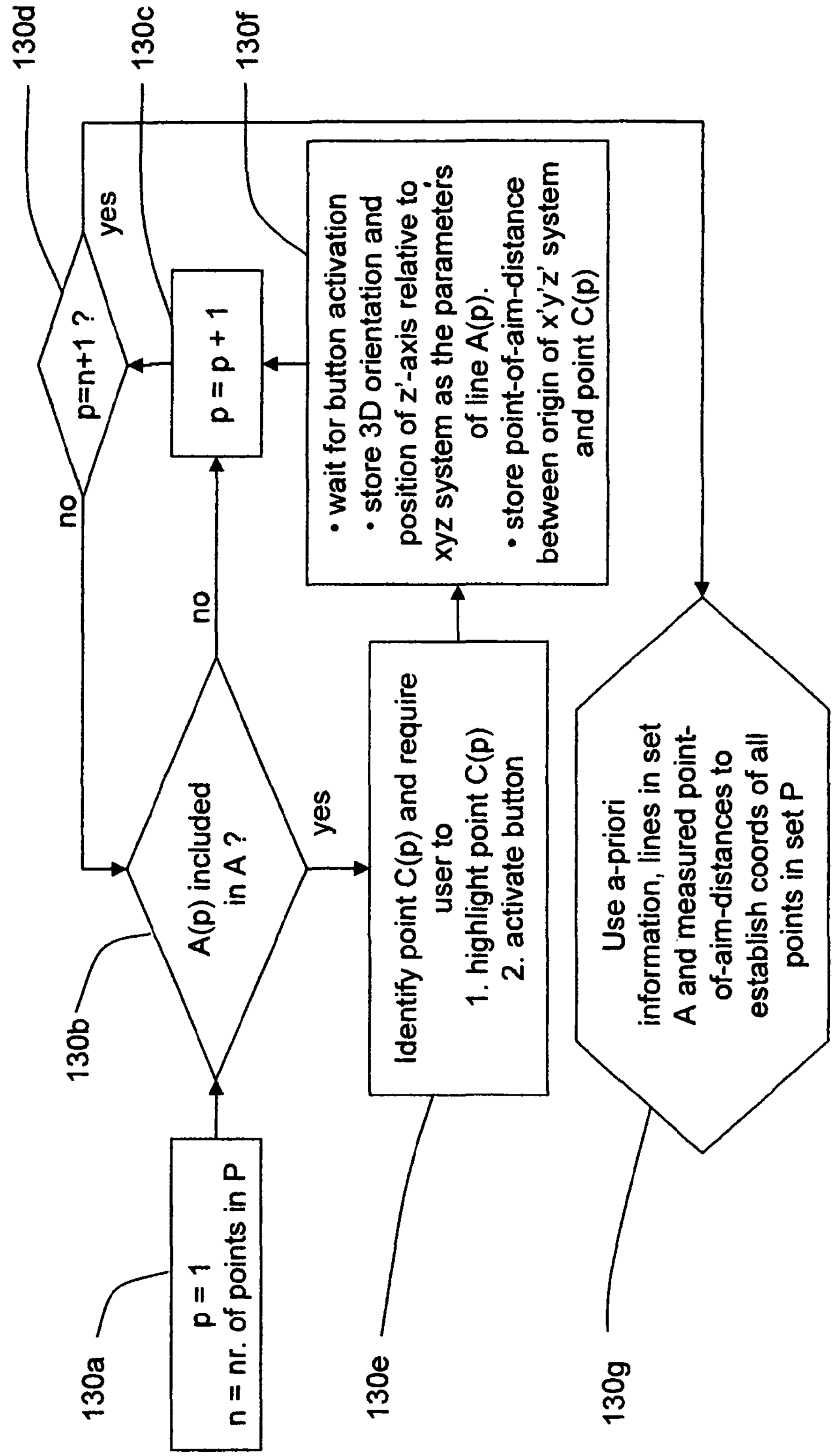

130a
p = 1
n = nr. of points in P
130b
A(p) included in A ?
yes
no
130c
p = p + 1
130d
p=n+1 ?
yes
no
130e
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
130f
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p).
• store point-of-aim-distance between origin of x'y'z' system and point C(p)
130g
Use a-priori information, lines in set A and measured point-of-aim-distances to establish coords of all points in set P

Fig. 12

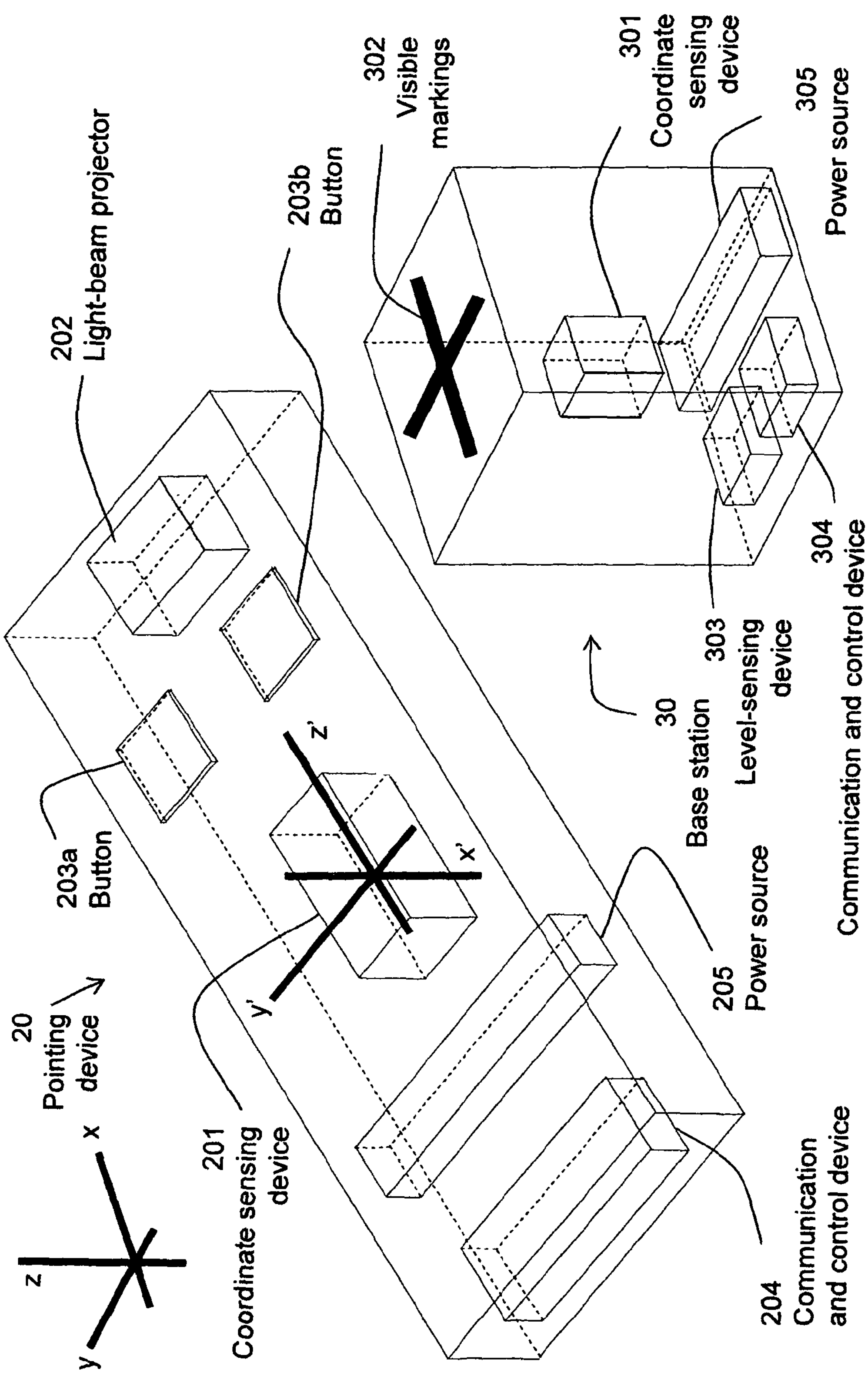

202
Light-beam projector
203b
Button
302
Visible
markings
301
Coordinate
sensing
device
305
Power source
203a
Button
z'
x'
y'
20
Pointing
device
z
x
y
201
Coordinate sensing
device
205
Power source
30
Base station
303
Level-sensing
device
304
Communication and control device
204
Communication
and control device

Fig. 13

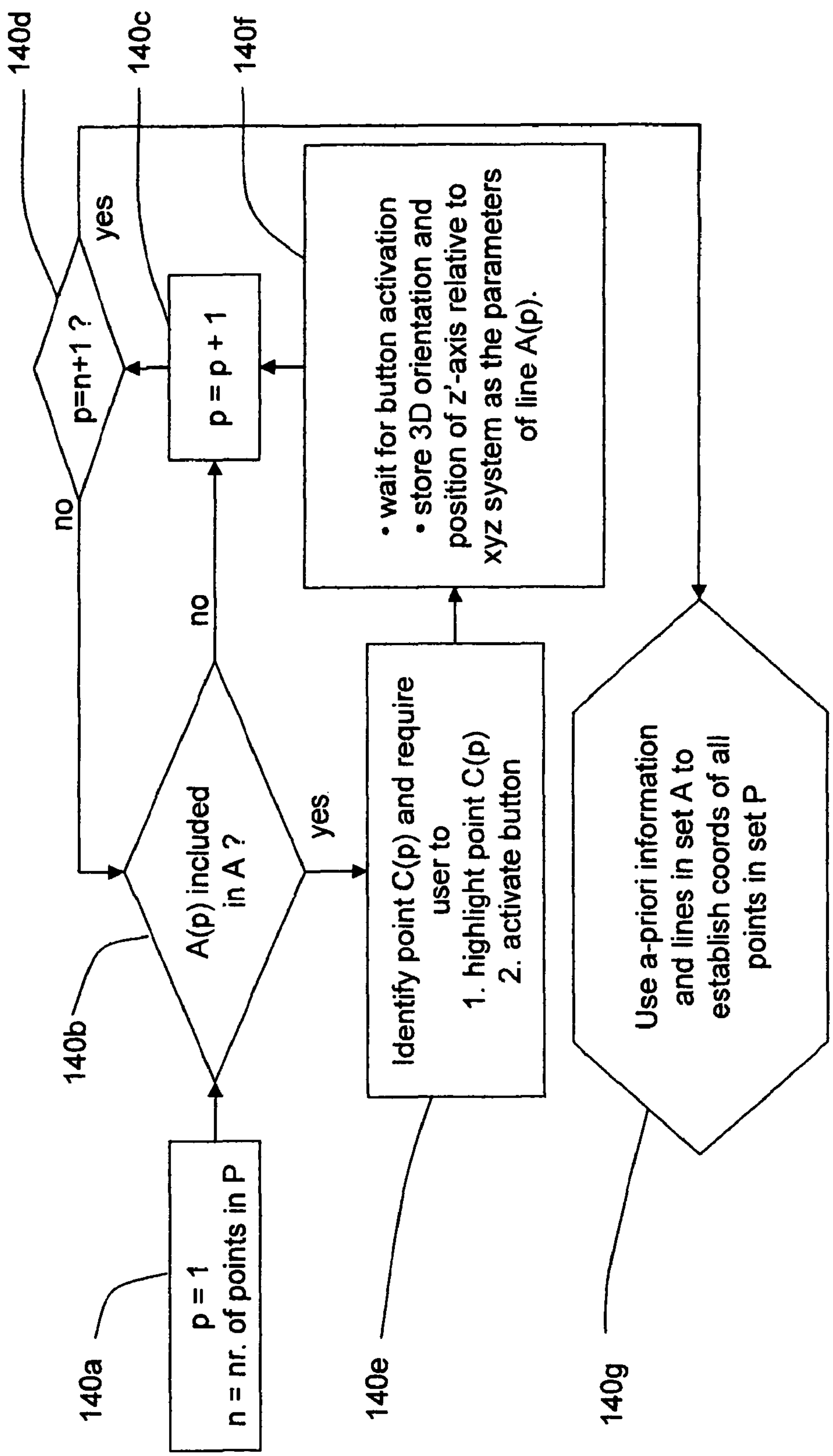

140d
140c
140f
140a
p = 1
n = nr. of points in P
140b
A(p) included in A ?
no
yes
p = p + 1
p=n+1 ?
no
yes
140e
Identify point C(p) and require user to
1. highlight point C(p)
2. activate button
• wait for button activation
• store 3D orientation and position of z'-axis relative to xyz system as the parameters of line A(p).
140g
Use a-priori information and lines in set A to establish coords of all points in set P

Fig. 14

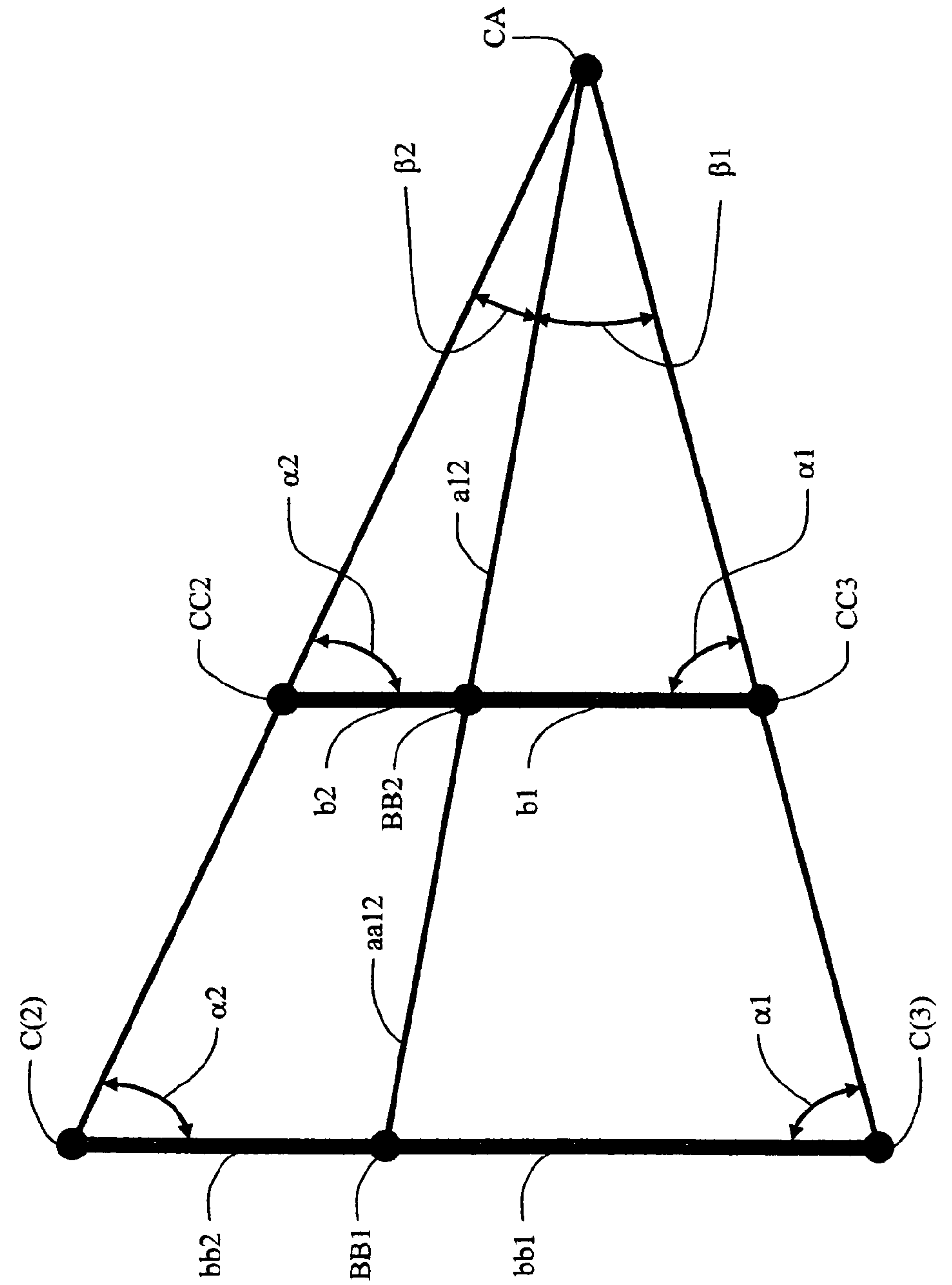


Fig. 15

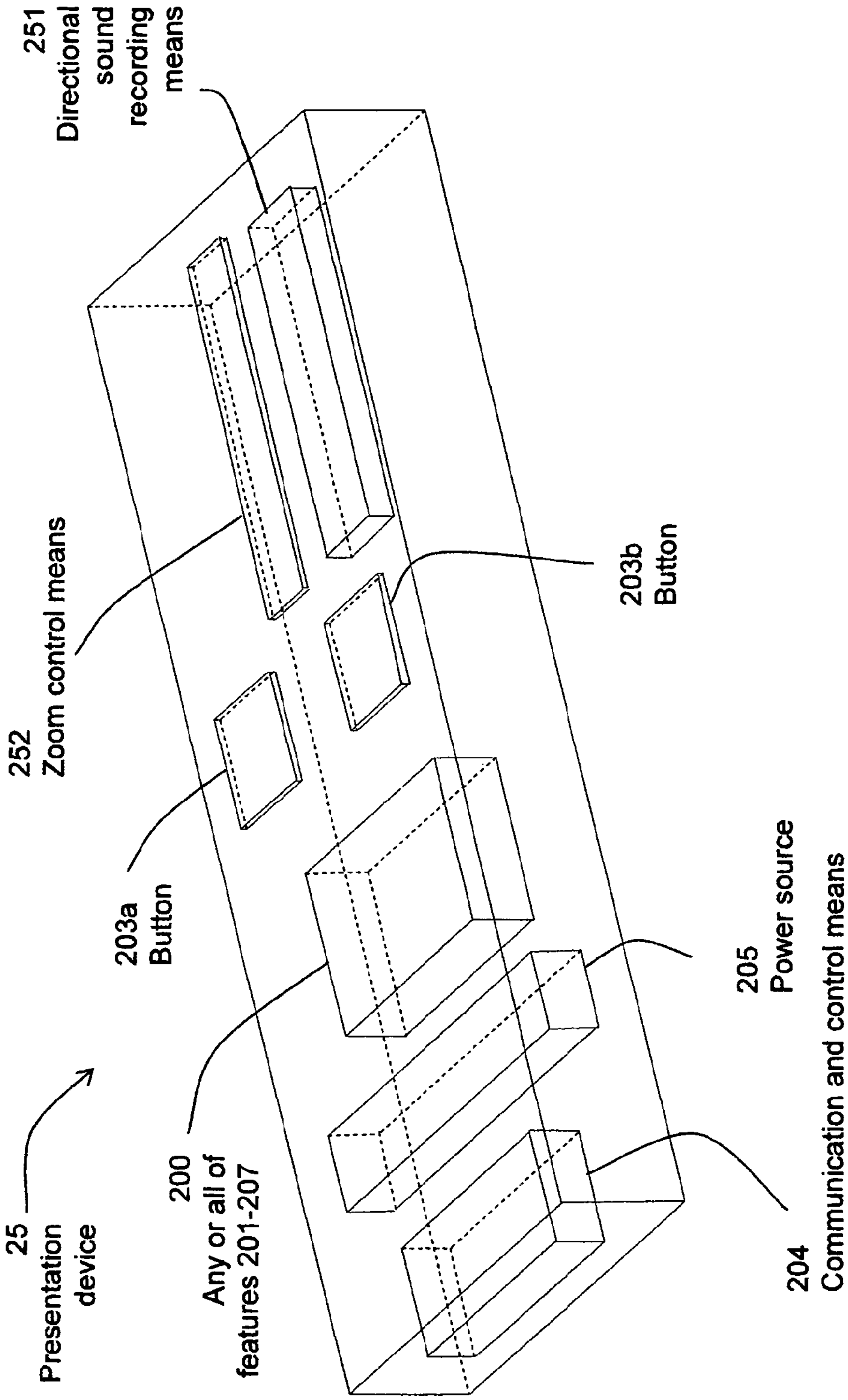

251
Directional sound recording means
252
Zoom control means
203b
Button
203a
Button
200
Any or all of features 201-207
205
Power source
25
Presentation device
204
Communication and control means

Fig. 16

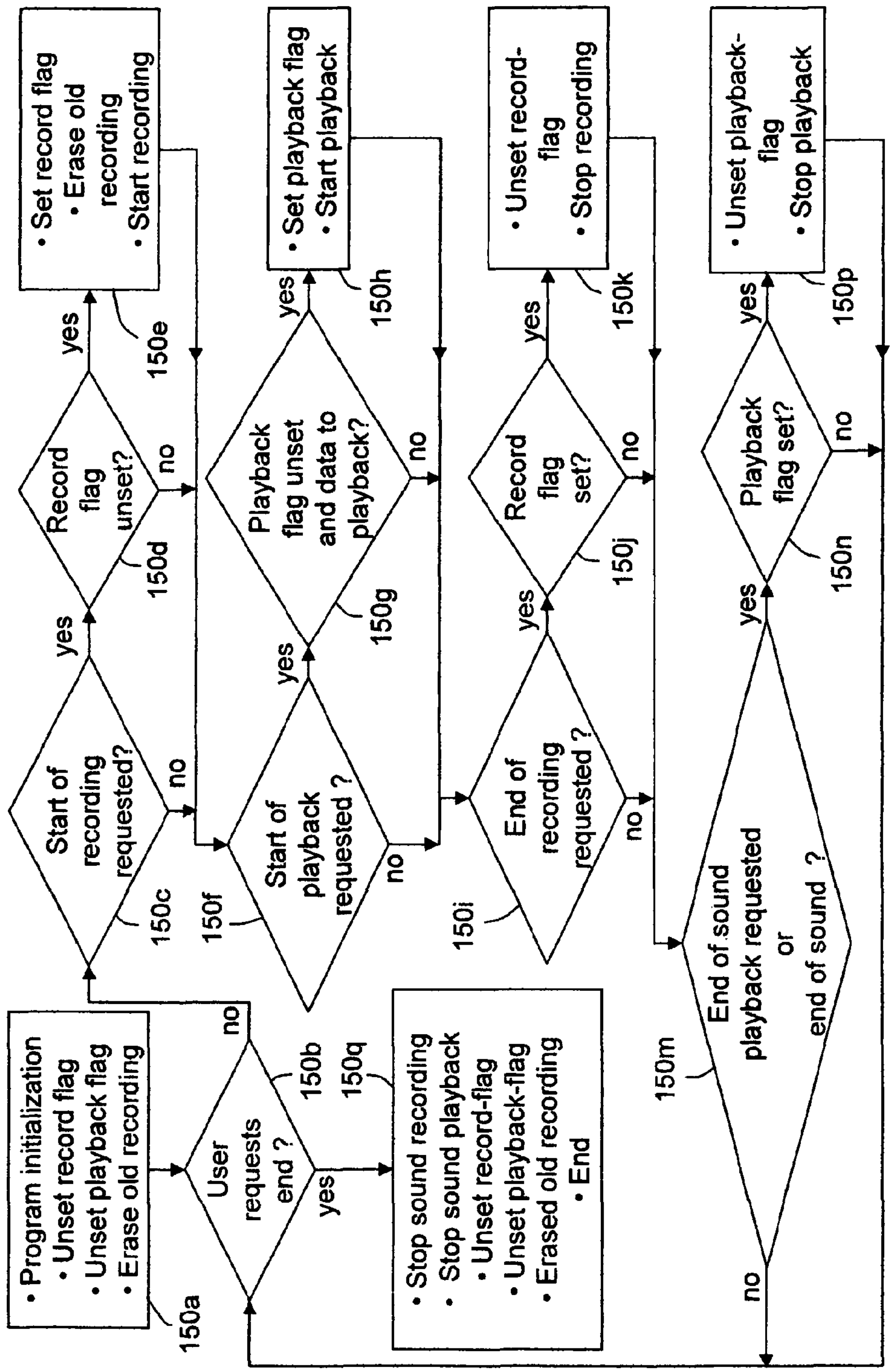

• Program initialization
• Unset record flag
• Unset playback flag
• Erase old recording
150a
User requests end ?
150b
yes
no
• Stop sound recording
• Stop sound playback
• Unset record-flag
• Unset playback-flag
• Erased old recording
• End
150q
Start of recording requested?
150c
yes
no
Record flag unset?
150d
yes
no
• Set record flag
• Erase old recording
• Start recording
150e
Start of playback requested ?
150f
yes
no
Playback flag unset and data to playback?
150g
yes
no
• Set playback flag
• Start playback
150h
End of recording requested ?
150i
yes
no
Record flag set?
150j
yes
no
• Unset record-flag
• Stop recording
150k
End of sound playback requested or end of sound ?
150m
yes
no
Playback flag set?
150n
yes
no
• Unset playback-flag
• Stop playback
150p

Fig. 17

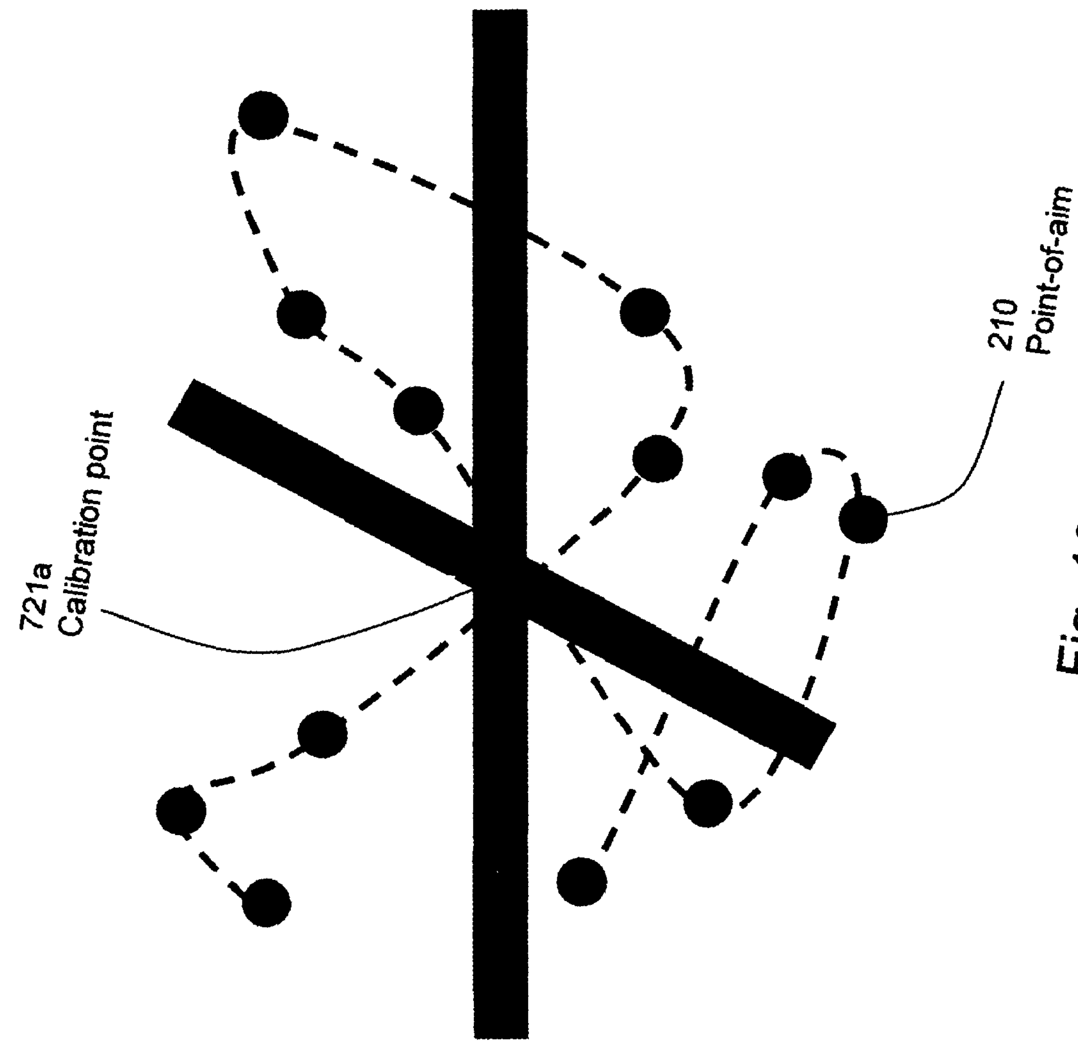


Fig. 18

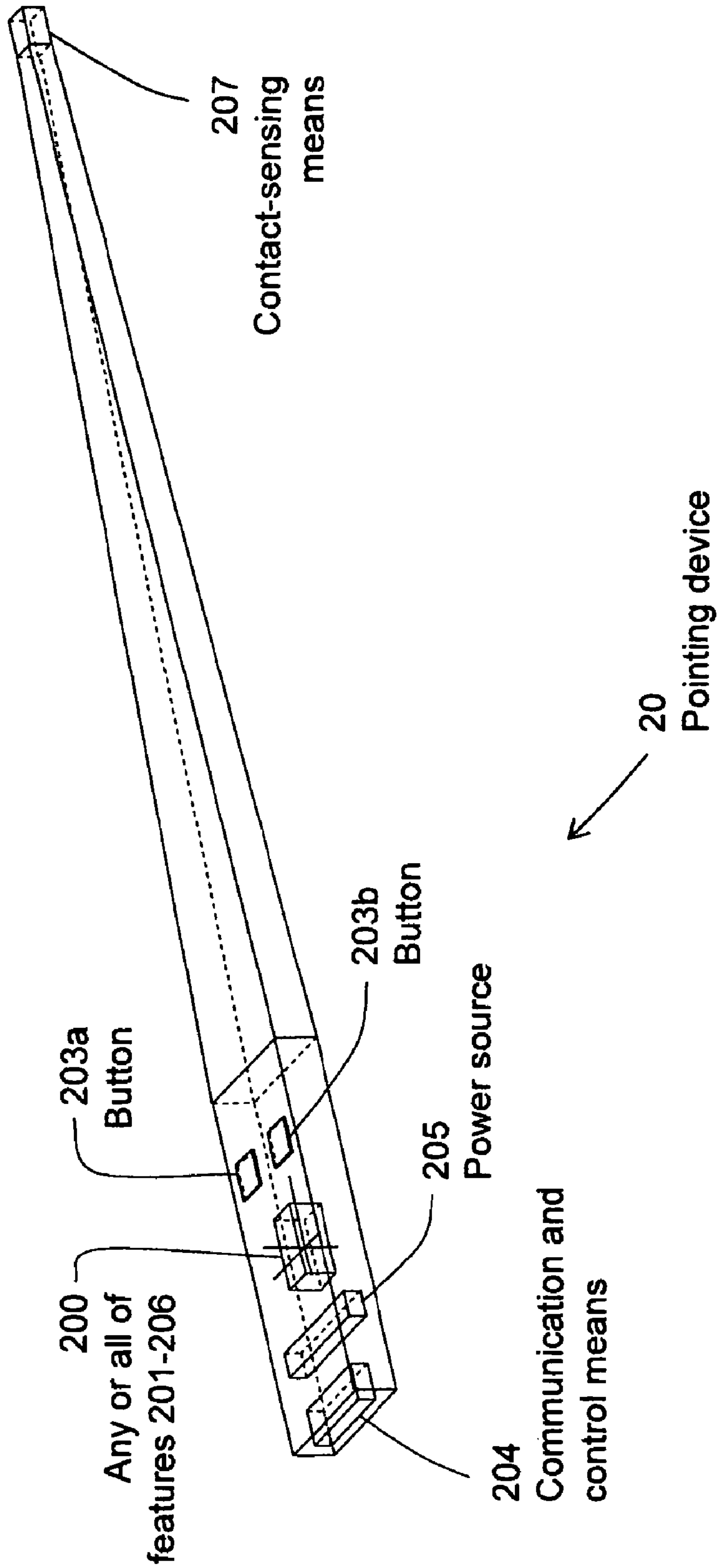

207
Contact-sensing means
20
Pointing device
203a
Button
203b
Button
205
Power source
200
Any or all of features 201-206
204
Communication and control means

Fig. 19

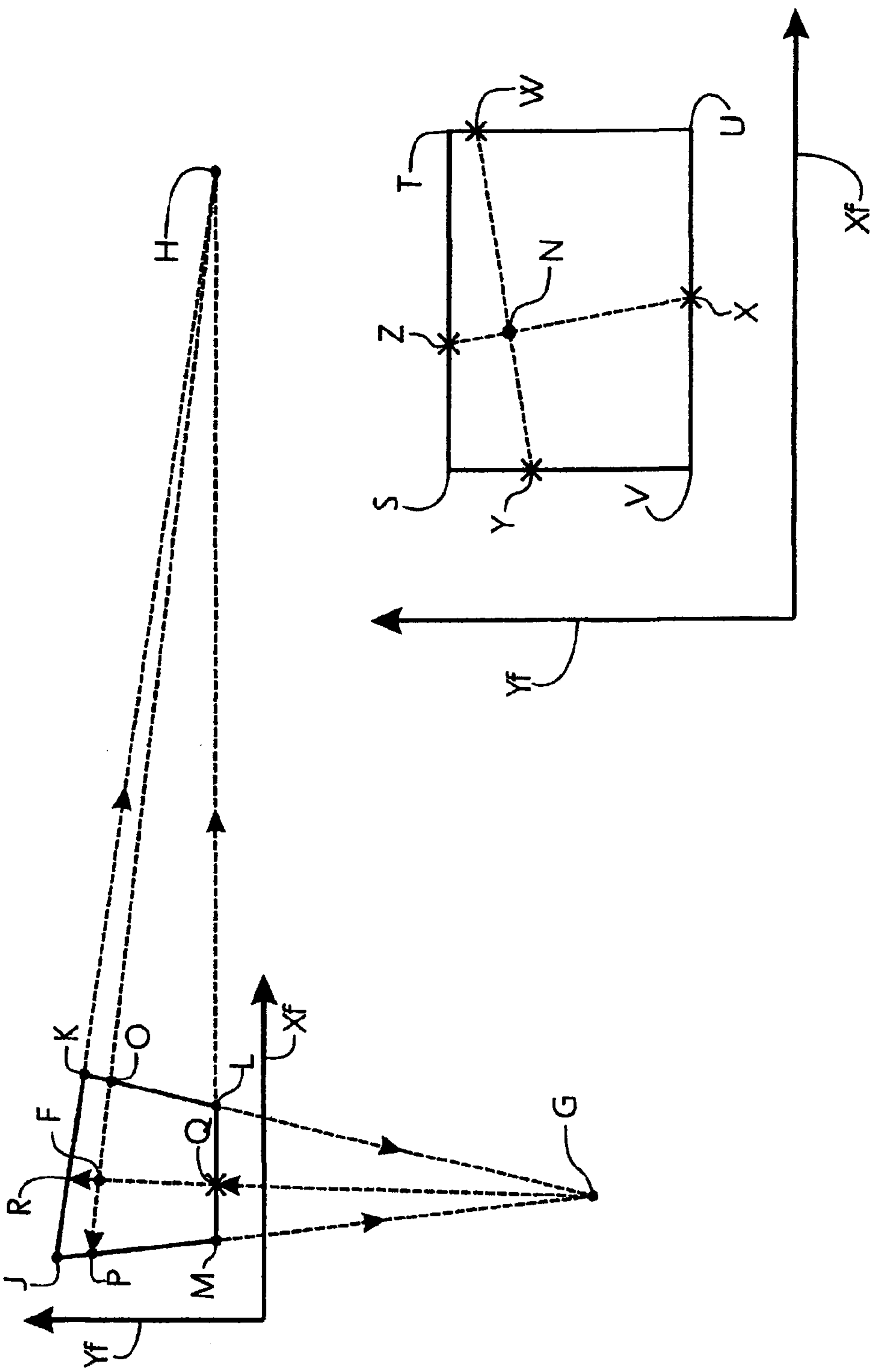


Fig. 20

EASILY DEPLOYABLE INTERACTIVE DIRECT-POINTING SYSTEM AND PRESENTATION CONTROL SYSTEM AND CALIBRATION METHOD THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of application Ser. No. 11/135,911, filed May 24, 2005 now U.S. Pat. No. 7,746,321, which is hereby incorporated by reference, which in turn claims priority from U.S. Provisional Application No. 60/575,671 filed on May 28, 2004 and from U.S. Provisional Application No. 60/644,649 filed on Jan. 18, 2005.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to devices for making presentations in front of audiences and, more specifically, to devices and methods for making presentations for which interaction with the displayed information through direct-pointing is desired or for which verbal interaction with the audience may be anticipated.

2. Background Art

Technology for presenting computer-generated images on large screens has developed to the point where such presentations are commonplace. For example, the software package POWERPOINT, sold by Microsoft Corp., Redmond, Wash., may be used in combination with a so-called 'beamer' to generate interactive presentation material and project for viewing by an audience. Often, such presentations are held in rooms not specifically equipped for the purpose of showing presentations, in which case use is made of a portable beamer in combination with a so-called 'laptop' computer. Under these circumstances the projection surface may be a wall of the room.

During a presentation it is desirable for the presenter to be able to move freely in front of the audience while retaining the capability to interact with the presentation and point to specific features on the displayed images. It would also be desirable for the presenter to be able to capture verbal comments made by members of the audience so as to amplify and/or play them back to the larger audience.

In general, interaction with a computer is often facilitated by pointing devices such as a 'mouse' or a 'trackball' that enable manipulation of a so-called 'cursor'. Traditionally, these devices were physically connected to the computer, thus constraining the freedom-of-movement of the user. More recently, however, this constraint has been removed by the introduction of wireless pointing devices such as the GYROMOUSE, as manufactured by Gyration, Inc.

Broadly speaking, pointing devices may be classified in two categories: a) devices for so-called 'direct-pointing' and b) devices for so-called 'indirect-pointing'. Direct pointing devices are those for which the physical point-of-aim coincides with the item being pointed at, i.e., it lies on the line-of-sight. Direct pointing devices include the so-called 'laser pointer' and the human pointing finger. Indirect pointing devices include systems where the object of pointing (e.g., a cursor) bears an indirect relationship to the physical point-of-aim of the pointing device; examples include a mouse and a

trackball. It needs no argument that direct-pointing systems are more natural to humans, allowing faster and more accurate pointing actions.

Indirect pointing devices known in the art include the following. U.S. Pat. No. 4,654,648 to Herrington et al. (1987), U.S. Pat. No. 5,339,095 to Redford (1994), U.S.

U.S. Pat. No. 5,359,348 to Pilcher et al. (1994), U.S. Pat. No. 5,469,193 to Giobbi et al. (1995), U.S. Pat. No. 5,506,605 to Paley (1996), U.S. Pat. No. 5,638,092 to Eng et al. (1997), U.S. Pat. No. 5,734,371 to Kaplan (1998), U.S. Pat. No. 5,883,616 to Koizumi et al. (1999), U.S. Pat. No. 5,898,421 to Quinn (1999), U.S. Pat. No. 5,963,134 to Bowers et al. (1999), U.S. Pat. No. 5,999,167 to Marsh et al. (1999), U.S. Pat. No. 6,069,594 to Barnes et al. (2000), U.S. Pat. No. 6,130,664 to Suzuki (2000), U.S. Pat. No. 6,271,831 to Escobosa et al. (2001), U.S. Pat. No. 6,342,878 to Chevassus et al. (2002), U.S. Pat. No. 6,388,656 to Chae (2002), U.S. Pat. No. 6,411,277 to Shah-Nazaroff (2002), U.S. Pat. No. 6,492,981 Stork et al. (2002), U.S. Pat. No. 6,504,526 to Mauritz (2003), U.S. Pat. No. 6,545,664 to Kim (2003), U.S. Pat. No. 6,567,071 to Curran et al. (2003) and U.S. Patent Application Publication No. 2002/0085097 to Colmenarez et al. (2002). Each of the foregoing publications discloses a system for which the 2 dimensional or 3 dimensional position, orientation and/or motion of an object, such as a handheld pointing device, are measured with respect to some reference coordinate system using appropriate means. Such means include acoustic devices, electromagnetic devices, infrared devices, visible light emitting diode (LED) devices, charge coupled devices (CCD), accelerometer and gyroscopic motion detectors, etc. Although for some of the foregoing devices the reference coordinate system may be positioned close to the display means, no information on the actual position of the presentation display with respect to the system is used, causing the resulting pointing action to be inherently indirect and, hence, less natural to the human operators of such systems.

Other inherently indirect-pointing systems that do not require the position or orientation of the pointing device to be known include devices such as disclosed in U.S. Pat. No. 5,095,302 to McLean et al. (1992) and U.S. Pat. No. 5,668,574 to Jarlance-Huang (1997). The foregoing patents describe indirect-pointing methods that do not provide the speed and intuitiveness afforded by direct-pointing systems.

Direct pointing devices are disclosed, for example, in U.S. Pat. No. 4,823,170 to Hansen (1989), which describes a direct-pointing system comprising a light source, a position-sensing detector located adjacent to the light source and a focusing reflector that, in one application, is parabolic shaped and is attached to the pointing device. Additionally, procedures are described to calibrate the system. In the understanding of current applicant, however, the physical location of the position-sensing detector needs to be, at least preferably, adjacent to the display means. The system disclosed in the Hansel '170 patent cannot easily be ported to a room not specifically equipped for this system.

U.S. Pat. No. 5,929,444 to Leichner (1999) discloses a system primarily intended for target shooting practice, but an application as a direct-pointing cursor control apparatus may arguably be anticipated. The system includes transmitting and detecting equipment in a fixed reference base and a movable pointing device. A calibration routine is described that aligns the detecting and transmitting means while keeping the pointing device (i.e., a gun) aimed at the center of the target. The Leichner '444 patent does not describe methods or means that allow determination of a point-of-aim of a pointing device on a target of which the size and/or orientation have not been predetermined. Consequently, the system disclosed

in the Leichner '444 patent is not suitable to be used as a cursor control means for projection surfaces not specifically adapted to be used with such system.

U.S. Pat. No. 5,952,996 to Kim et al. (1999), U.S. Pat. No. 6,184,863 to Siben et al. (2001) and U.S. Patent Application Publication No. 2002/0084980 to White et al. (2002) disclose direct-pointing systems where the 3 dimensional position and/or orientation of the pointing device is measured with respect to sources and/or detectors, the physical position of which in relation to the display means is presumed known. Such systems only work in rooms specifically equipped for their use.

U.S. Pat. No. 5,484,966 to Segen (1996), U.S. Pat. No. 6,335,723 to Wood et al. (2002) and U.S. Pat. No. 6,507,339 to Tanaka (2003) disclose methods suitable for direct-pointing that are useful only if the pointing device is physically close to or touching the display area or volume, for example used with so-called 'interactive whiteboards'. Some of the foregoing patents describe appropriate pointer calibration routines. Such systems are not suitable for presentations where the display surface is out of the presenter's physical reach.

U.S. Pat. No. 6,104,380 to Stork et al. (2000) discloses a direct-pointing system in which at least the 3 dimensional orientation of a handheld pointing device is measured by appropriate means. Additionally, a direct measurement is made of the distance between the pointing device and the displayed image. However, the system disclosed in the Stork et al. '380 patent does not include methods to ascertain the position and orientation of the display means relative to the pointing device. In the foregoing system, these appear to be presumed known. This is also the case for a system disclosed in U.S. Pat. No. 4,768,028 to Blackie (1988), in which the orientation of a helmet-mounted direct-pointing apparatus is measured electromagnetically. The foregoing systems therefore appear to be ill-suited to operate in rooms not specifically equipped for presentation purposes.

U.S. Pat. No. 6,373,961 to Richardson et al. (2002) discloses a direct-pointing system using helmet-mounted eye tracking means. The point-of-gaze relative to the helmet is measured as well as the position and orientation of the helmet relative to the display. The latter is accomplished by equipping the helmet either with means to image sources mounted at fixed positions around the display or with means to image a displayed calibration pattern. Of course, the foregoing system relies on sophisticated helmet mounted equipment capable of, among other things, tracking eye-movement. Moreover, such a system relies on an unobstructed line-of-sight with respect to the display and a substantially constant distance from the display to the helmet-mounted equipment. The disclosed invention does not lend itself to be easily used by a human operator in an arbitrary (not predetermined) presentation setting.

U.S. Pat. No. 6,385,331 to'Harakawa et al. (2002) discloses a system that uses infrared technology in combination with image recognition software to distinguish pointing gestures made by the presenter, without the need for an artificial pointing device. The disclosed system, however, requires the presentation room to be set up with highly tuned and sophisticated equipment, and is therefore not easily ported to a different venue.

U.S. Pat. No. 6,404,416 to Kahn et al. (2002) discloses a direct-pointing system where a handheld pointing device is equipped with an optical sensor. In such system either the display is required to be of a specific type (e.g., a cathode ray-based display that uses an electron beam) or the displayed image is required to be enhanced by timed and specific emanations. When pointed to the display, a handheld pointing device may detect the electron beam or the timed emanations, and the timing of these detections may then be used to ascertain the point-of-aim. The disclosed system is somewhat similar to the technologies used for so-called light guns in video games as disclosed, for example, in U.S. Pat. No. 6,171,190 to Thanasack et al. (2001) and U.S. Pat. No. 6,545,661 to Goschy et al. (2003). Of course, such systems require either a specific display apparatus or a specialized modification of the displayed images. Moreover, an uncompromised line-of-sight between the pointer and the display is a prerequisite for such systems.

U.S. Patent Application Publication No. 2002/0089489 to Carpenter (2002) discloses a direct-pointing system that, in one embodiment, positions a computer cursor at a light spot projected by a laser-pointer. The system relies on the use of an image capturing device to compare a captured image with a projected image. As such, the system disclosed in the '489 patent application publication makes use of calibration routines in which the user is required to highlight computer-generated calibration marks with the laser pointer. The system disclosed in the '489 patent application publication is not unlike a system disclosed in U.S. Pat. No. 5,502,459 to Marshall et al. (1996). Also, U.S. Pat. No. 5,654,741 to Sampsell et al. (1997), U.S. Pat. No. 6,292,171 to Fu et al. (2001), U.S. Patent Application Publication No. 2002/0042699 to Tanaka et al. (2002) and U.S. Patent Application Publication No. 2002/0075386 to Tanaka (2002) all disclose systems that can detect a light-spot using optical means. Such systems specifically generally require the use of computationally expensive image processing technologies. All of these inventions require a projection surface with adequate diffusion properties, as well as some form of optical system with a steady and uncompromised view of the display area. As such, they limit the freedom-of-movement of the presenter and place limitations on the position and optical characteristics of the necessary equipment. Also, in some of these inventions fast and involuntary movement of the user's hand may result in a cursor that does not move smoothly or a cursor that does not perfectly track the light spot, causing possible confusion with the user.

Other pointing systems known in the art may be classified as other than entirely direct-pointing or indirect-pointing systems. Such systems include one disclosed in U.S. Pat. No. 6,417,840 to Daniels (2002), which is combination of a cordless mouse with a laser pointer. Although this system incorporates a direct-pointing device (i.e., the laser pointer), the method used by the system for interacting with the presentation is indirect (i.e., by means of the mouse) and therefore does not afford the fast and more accurate interactive pointing actions provided by some other direct-pointing systems described in some of the foregoing publications.

Another system known in the art that uses both direct and indirect-pointing methods is described in U.S. Pat. No. 6,297,804 to Kashitani (2001). The disclosed system is a system for pointing to real and virtual objects using the same pointing device. In the disclosed system, the pointing means switch between a computer controlled light source (e.g., a laser) and a conventional computer cursor, depending on whether or not the user's intended point-of-aim has crossed a boundary between the real and virtual display (i.e., computer-displayed imagery). Various methods are described to establish these boundaries. Although the computer-controlled light source may be regarded as pointing in a direct manner, its point-of-aim is essentially governed by the system operator using an

indirect-pointing system such as a mouse. Thus, the disclosed system does not allow for the desired flexibility afforded by truly direct-pointing methods.

Other systems known in the art include those such as disclosed in U.S. Pat. No. 5,796,386 to Lipscomb et al. (1998), which discloses a calibration procedure to establish the relation between coordinate systems associated with a handheld device and, in one embodiment, a display unit. The system disclosed in the Lipscomb et al. '386 patent may arguably be applicable as a direct-pointing cursor control system. The disclosed calibration routine requires the user to register at least three 3 dimensional positions of the handheld device with a central processing unit. The disclosed system does not appear to include calibration methods for the case where the display unit is out of physical reach of the system operator. The system is thus not practical for use at an arbitrary venue.

U.S. Pat. No. 6,084,556 to Zwern (2000) discloses a head-mounted display unit that displays information governed by the orientation of the apparatus, as measured by a tracking device. This way, the system creates the illusion of a large virtual display that is being looked at by the system operator. Of course, the large display alluded to does not constitute a projected presentation. Also, no methods are disclosed in the Zwern '556 patent to establish the relative position of the head-mounted apparatus with respect to the display.

U.S. Patent Application Publication No. 2002/0079143 to Silverstein et al. (2002) discloses a system in which the position of a movable display with respect to a physical document is established. The '143 patent application publication describes calibration routines in which the user is required to activate a registration button when the movable display is over some predetermined position on the physical document. The disclosed system only relates to 2 dimensional applications and, moreover, cannot be used in situations where the interaction region is out of the system operator's physical reach.

U.S. Pat. No. 5,339,095 to Redford (1994) discloses an indirect-pointing system where the pointing device is equipped with non-directional microphone. Also, U.S. Pat. No. 5,631,669 to Stobbs et al. (1997) discloses the inclusion of a nondirectional microphone unit in an indirect-pointing device.

SUMMARY OF THE INVENTION

One aspect of the invention is a method for controlling a parameter related to a position of a computer display cursor based on a point-of-aim of a pointing device within an interaction region. The method includes projecting an image of a computer display to create the interaction region. At least one calibration point having a predetermined relation to the interaction region is established. A pointing line is directed to substantially pass through the calibration point while measuring a position of and an orientation of the pointing device. The pointing line has a predetermined relationship to said pointing device. The parameter related to the position of the cursor within the interaction region is controlled using measurements of the position of and the orientation of the pointing device.

Another aspect of the invention is a method for controlling a computer display cursor in an interaction region. According to this aspect, the method includes establishing a calibration point having a predetermined relation to the interaction region. At least one of a position and orientation of a pointing line is first measured while directing the pointing line to substantially pass through the calibration point. The first measurement is used to constrain a parameter of the calibration point. The pointing line has a predetermined relationship to at least one of position and orientation of a pointing device. A characteristic feature of the interaction region is used to establish a property of a common point of the pointing line and the interaction region measured relative to the interaction region. At least one of position and orientation of the pointing device is measured, and the characteristic feature of the interaction region and measurement of the pointing device are used to control the cursor on a computer display image.

Another aspect of the invention is a method for controlling a parameter related to position of a cursor on a computer screen image. The method according to this aspect includes measuring a first angle between a pointing line and a first line, and measuring a second angle between the pointing line and a second line. The first line is related in a predetermined way to a geographic reference, and the second line is related in a predetermined way to a geographic reference. The pointing line has a predetermined relation to said pointing device. A first parameter related to the first angle, and a second parameter related to the second angle are used to control the parameter of the cursor on said computer screen image, whereby the cursor position parameter is controlled by movement of the pointing device.

Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a pointing device and base station according to a first embodiment.

FIG. **2** shows a presentation venue and computer screen.

FIG. **3** shows program steps for selection of appropriate assumptions according to embodiments 1, 2 and 3.

FIG. **4** shows program steps for construction of information set according to a first embodiment.

FIG. **5** shows program steps for ascertaining necessary 3D data according to a first embodiment.

FIG. **6** shows program steps for control of pointing device elements and computer cursor according to several embodiments.

FIG. **7** shows one example of a first embodiment.

FIG. **8** shows a second example of one embodiment of the invention.

FIG. **9** shows a third example of one embodiment.

FIG. **10** shows a pointing device and base station according to a second embodiment.

FIG. **11** shows program steps for construction of information set according to a second and third embodiment.

FIG. **12** shows program steps for ascertaining necessary 3D data according to the second embodiment.

FIG. **13** shows a pointing device and base station according to a third embodiment.

FIG. **14** shows program steps for ascertaining necessary 3D data according to the third embodiment.

FIG. **15** shows projection of interaction structure on horizontal and vertical planes.

FIG. **16** shows a presentation device according to a fourth embodiment.

FIG. **17** shows program steps for sound recording and playback according to the fourth embodiment.

FIG. **18** shows an image of calibration point and light spots at the points-of-aim.

FIG. **19** shows an alternative embodiment of pointing device.

FIG. **20** shows a prior art: construction of method M for a quadrangle.

DETAILED DESCRIPTION

A first embodiment of the invention will be described with reference to FIG. **1**. A pointing device **20** has associated with it a coordinate system x' y' z'. A portable base station **30** has associated with it a coordinate system x y z. Pointing device **20** and base station **30** may be equipped with coordinate sensing devices, **201** and **301**, respectively, that enable measurement of the 3 dimensional position and 3 dimensional orientation of pointing device **20** and, therefore, of a pointing line **21** (see also FIG. **2**) that substantially intersects pointing device **20**, all measured relative to the x y z coordinate system. Pointing line **21** may substantially coincide with the long axis of pointing device **20**. For example, coordinate sensing devices **201** and **301** may be electromagnetic tracking devices, such as the 3SPACE FASTRAK® system, manufactured by Polhemus, a Kaiser Aerospace & Electronics Company, Colchester, Vt. Alternatively, coordinate sensing device **201** and **301** may be based on ultrasonic tracking systems such as those used in the LOGITECH 2D/6D computer mouse, commercially available from Logitech Inc., Fremont, Calif. Other embodiments for coordinate sensing device **201** and **301** may include, without limitation, sensors based on LEDs, CCDs, accelerometers, inclinometers, gyroscopes, compasses, magnetometers, etc. Also, combinations of such different types of sensors may be used to acquire redundant measurements for quality control purposes. For example, a controlled-source electromagnetic position tracking system may be combined with compasses and inclinometers. Those skilled in the art will appreciate that independent measurements of the Earth's magnetic field and gravity may be used to enhance the measurements made by a controlled-source position detecting system. In the invention, any system may be used that is capable of determining at least parts of the orientation and position in three dimensions, with respect to coordinate system x y z, of a line-segment that substantially intersects pointing device **20**.

Base station **30** may comprise a plurality of related physical entities, such as described in U.S. Pat. No. 6,608,668 to Faul et al. (2003); for clarity of explanation one of these physical entities will be associated with coordinate system x y z and be denoted as base station **30**, the center of which substantially coincides with the origin of coordinate system x y z. For purposes of explanation of the invention, the origin of coordinate system x' y' z' substantially coincides with the center of pointing device **20**, and the z'-axis is substantially aligned with the long axis of pointing device **20**.

Pointing device **20** may also be provided with a light-beam projector **202**, for example a laser. The physical position and orientation of the projected beam of light with respect to coordinate system x' y' z' may be established with suitable accuracy at the place of manufacture of the pointing device **20** and may be presumed to be known. For purposes of explanation, the beam of light from the light beam projector **202** substantially coincides with the z'-axis. Additionally, one or more control buttons **203***a*, **203***b* or the like may be provided, as well as communication and control device **204**. Communication and control device **204** may be used to control various features of pointing device **20** and may also communicate via wire, or wirelessly, with base station **30** and/or a central processing unit (not shown separately), such as a COMPAQ Armada 'M700 as manufactured by Hewlett Packard Company, Palo Alto, Calif. The central processing unit may also control a presentation with which user interaction is desired. For clarity of the description which follows, the central processing unit will be referred to hereinafter as "the computer." Furthermore, pointing device **20** may include an internal power source **205**, for example a battery, or instead may be connected such as by wire to an external power source.

In addition to coordinate sensing device **301**, base station **30** may be provided with communication and control device **304**. Communication and control device **304** may be used to control various features of base station **30**. Communication and control device **304** may communicate with pointing device **20** and/or with the computer (not shown) that may control the presentation images. The communication and control device **304** may use wired or wireless technology. In the present embodiment communication with the computer occurs via a universal serial bus (USB) compatible device or the like (not shown). Communication and control device **304** may communicate wirelessly with a relay device (not shown) that communicates via a USB compatible device or the like with the computer (not shown) that may control the presentation with which user-interaction is desired. There may be visible markings **302** on base station **30** that indicate the orientation of one or more coordinate planes defined by prescribed relations between coordinates x, y, z, as well as features of the position of the origin of the x y z coordinate system. For example, a line may be used to indicate the z-x-plane of the x y z coordinate system, for which the y-coordinate is zero; another line may be used to indicate the z-y plane, for which the x-coordinate is zero. Base station **30** may be provided with a level sensing device **303** to determine whether or not one of the coordinate planes of coordinate system x y z is substantially horizontal. Level-sensing device **303** may measure two angles or equivalent characteristics that define the orientation of one of the coordinate planes of coordinate system x y z with respect to a horizontal surface. Level sensing device **303** can be a device such as disclosed in U.S. Pat. No. 6,466,198 to Feinstein (2002), which makes use of model ADXL202 accelerometers sold by Analog Devices Inc., Norwood, Mass. The disclosed accelerometers provide tilt angle information depending on their inclination relative to Earth's gravity. It will be apparent to those skilled in the art that many other types of sensors may be used as embodiment for level-sensing device **303**, for example, capacitance-type bubble levels. See, for example, U.S. Pat. No. 5,606,124 to Doyle et al. Finally, base station **30** may be equipped with a power source **305**, for example a battery, or may have a connection to an external power source.

Referring to FIG. **2**, a projection device **40** is arranged to project an image **50** generated by, for example, the computer (not shown). The projection device **40** may be used to generate a projection image **70** on a projection region **60**. For example, projection device **40** may be a 2000 lumen projector, model XL8U, manufactured by Mitsubishi Corp. Projection region **60** may be a surface, such as a wall or a projection screen. The projection region **60** may define a flat plane or a may define a more elaborate 2 dimensional (20) or even 3 dimensional (3D) structure. In FIG. **2**, projection region **60** is shown as a screen, but this is only for purpose of illustrating the principle of the invention and is not intended to limit the scope of the invention. Alternatively the combination of projection device **40** and projection region **60** may be incorporated in one and the same physical device, such as a television receiver (cathode ray tube display), liquid crystal display (LCD) screen or the like.

There is a region of space that is designated as a region on which interaction with the user is desired. This region is

denoted as the interaction region **71**. The interaction region **71** may be flat (planar) or may be a more elaborate 2D or even 3D structure. The interaction region **71** may have features in common with projection image **70** and may be associated in some way with a computer screen interaction region **51**. In the present embodiment, however, it will be assumed that interaction region **71** or a scaled version thereof, is substantially part of or substantially coincides with projection image **70**. Moreover, it will be assumed in this embodiment that interaction region **71** substantially coincides with the projection of computer screen interaction region **51** as projected by projection device **40**.

For display systems which include a separate projection device **40** and projection region **60**, the optical axis of projection device **40** may not be aligned with any vector normal to projection region **60**. Moreover, projection region **60** may not be flat and therefore may not even be a 2D shape. Consequently, projection image **70** and interaction region **71** may in general not be flat or rectangular, even if the imagery generated by the computer is scaled so as to be presented in rectangular form. In this embodiment, however, it is assumed that projection region **60**, projection image **70** and interaction region **71** are substantially flat. Furthermore, it is assumed in this embodiment that interaction region **71** is substantially a quadrangle and that the associated computer screen interaction region **51** is substantially rectangular.

Additionally, calibration points **721***a*, **721***b*, **721***c*, **721***d* may be provided that may define characteristic features of interaction region **71**. For example, interaction region **71** may be trapezoidal in shape, in which case calibration points **721***a*, **721***b*, **721***c*, **721***d* may define corners of interaction region **71** or corners of a scaled version thereof. Furthermore, screen marks **521***a*, **521***b*, **521***c*, **521***d* may be provided, and may but need not be associated with calibration points **721***a*-**721***d*. For example, calibration points **721***a*-**721***d* may coincide with the projected versions of screen marks **521***a*-**521***d* and may in this way be identified by projection device **40**. Calibration points **721***a*-**721***d* may also be identified by other means than projection, for example by unique descriptions such as the 'upper right corner of interaction region **71**', 'center of interaction region **71**,' etc.

The operation of the present embodiment will now be described with reference to FIGS. **1**, **2** and **3**. A display system is set up at the venue where a presentation is to made, which can be a combination of a portable projection device **40** and projection surface **60**, for example a wall. The display system is connected, using appropriate interconnection devices, to the computer (which may be in the base station **30** or located elsewhere) that generates the presentation images.

The system user positions base station **30** at a convenient location, preferably not far from where the user intends to make the presentation display. The user may position base station **30** in such a way that one of the coordinate planes of the x y z coordinate system is substantially parallel or substantially coincident with projection region **60**. The visual markings **302** may assist in such positioning. Subsequently, the user connects base station **30** to the computer (not shown), for example via a USB compatible device connection (not shown), or using a wireless relay device (not shown). The computer may be disposed in the base station **30** in some embodiments. In some embodiments, the computer may recognize the base station connection and start a program, part of which may be contained in the communication and control device **304**, in communication and control device **204**, or ill control logic contained in the wireless relay device (not shown). Alternatively, the user may be required to load the program into the computer manually via a CD-ROM drive, a floppy drive, memory stick (USB mass storage device—not shown) or the like. However it is loaded into the computer, the program may initiate a calibration routine that has as its object establishment of the shape, position, size and orientation of a defined interaction structure **72** relative to the x y z coordinate system. The interaction structure **72** is assumed to substantially coincide with interaction region **71**. The operation of the program will now be explained with reference to FIG. **3**.

At **80***a* the program is initiated. During step **80***b* a default assumption is made regarding interaction region **71**. Specifically, interaction region **71** is assumed to substantially coincide with a well-defined interaction structure **72** (FIG. **2** shows an interaction region **71** and an interaction structure **72** that are clearly not identical; this difference is however only meant as an example, and as a practical matter is preferably as small as possible). At **80***b* default values are entered for the orientation and position of this interaction structure **72**. For example, the default setting may assume interaction region **71** to substantially coincide with an interaction structure **72** that is a (flat) quadrangle positioned in a vertical plane that substantially intersects the origin of the x y z coordinate system associated with base station **30**. As another example, the default setting may provide that interaction region **71** substantially coincides with an interaction structure **72** that is an isosceles trapezoid of which the parallel edges are horizontal and of which the position is unknown. Using such default values, calibration points **721***a*-**721***d* not only define characteristic features of interaction region **71** but also of interaction structure **72**.

At **80***c* a decision is made whether the default values for interaction region **71** and interaction structure **72** should be accepted or overridden by the user. In making this decision, input from level-sensing device **303** and visible markings **302** on base station **30** may be used. If the defaults are to be accepted, the program continues to **80***j*, the details of which are explained below with reference to FIG. **4**. If the defaults are overridden, the program continues at **80***d* to **80***i*, during each of which the user may override any of the default settings. The user may be aided during any of **80***d* to **80***i* by a library of predetermined shapes, predetermined orientations and/or predetermined positions, or the user can be provided by the program with the capability to construct custom shapes, orientations and/or positions. In any case, the program continues to **80***j*.

It will be appreciated by those skilled in the art that once an assumption has been made regarding the shape of interaction structure **72**, it is possible to construct a set of three dimensionally distributed points in space that completely determines the 3D position, orientation and size of the interaction structure **72**. The number of points in the set will depend on the complexity of the assumed shape and the ingenuity with which the points are chosen. For example, a rectangular shape that is arbitrarily oriented in space is completely determined by a set of 3 points that coincide with 3 of its corners, but is also completely determined by a set of 8 points, pairs of which may determine each of the four edges of the rectangle.

Referring to FIG. **4**, describing details of program element **80***j*, the computer program continues at **90***a*, at which a set P is generated that includes a quantity n of points in space, each represented as C(i) ($0<i<n+1$), that uniquely determine interaction structure **72**, together with descriptions of their roles in determining this structure. For example, if the program elements outlined in FIG. **3** reveal that interaction region **71** is assumed rectangular, set P may hold three points described as the upper-left corner, the lower-left corner and the upper-right corner of a rectangular interaction structure **72**. If, alternatively, the projection of computer screen interaction region **51**

is substantially rectangular, and this projected rectangle has the same center but is physically two times smaller than interaction structure **72**, the three points may be described as the upper-right corner, the lower-left corner and the lower-right corner of a rectangle that has the same center but is two times smaller than interaction structure **72**. Thus, by carefully choosing the points in set P together with their description, any interaction structure **72** may be completely determined.

In addition to set P, a 3D point CA and another 3D point CB are determined at **90***a*. These additional 3D points are determined so as to lie away from interaction region **71**, that is, they lie at some distance out of the plane that is closest to. or substantially contains interaction region **71**. The distance may be comparable to an edge of projection image **70**. For example, point CA may be determined to lie near projection device **40** and point CB may be determined to lie at a distance from point CA that may be equal to the distance between projection device **40** and projection surface **60** measured substantially parallel to projection surface **60**. Other choices for point CA and point CB may also be used. Additionally, sets A and B are generated during step **90***a*. Set A includes a number n of lines A(i), each of which connects point CA to one of the points C(i) (0<i<n+1) in set P. Likewise, set B holds a number n of lines B(i), each of which connects point Ca to one of the points C(i) (0<i<n+1) in set P. Finally, at **90***a*, counters a, b are both initialized to the value of n.

Flow then continues on to step **90***b*, where a decision is made whether the program elements outlined in FIG. **3** have revealed any information on the 3D position and orientation of interaction structure **72**. If the decision is positive flow continues to step **90***c*, where this information is used to establish a priori relationships between the coordinates of the points in set P. For example, the steps outlined in FIG. **3** may have revealed that interaction structure **72** is assumed to coincide with the x-z plane, in which case the a priori relationships may include the requirement that the y-coordinates of all points in set P are equal to zero. A pre-set library of a priori relationships may be provided to aid in the execution of this program element.

The program continues to **90***d*, which may also be reached from **90***b* if the decision at **90***b* is negative. At **90***d*, line B(b) is removed from set B, after which counter b is decremented by 1.

The program continues to **90***e*, where a decision is made whether complete 3D information on the lines in sets A and B, together with a priori information, constitutes enough information to uniquely determine the coordinates of all the points in set P. For example, the program elements outlined in FIG. **3** may have determined that interaction region **71** is assumed to be rectangular, but no information is known regarding its orientation or position. In this case set P may contain three points, corresponding to three corners of a rectangular interaction structure **72**. Each point C(i) (0<i<4) in set P would then be uniquely determined by the intersection of a line from set A and a line from set B if and only if sets A and B contained three lines each.

If the decision at **90***e* is negative, the program continues to **90***f*, where line B(b+1) is added once more to set B.

If the decision at **90***e* is positive, program flow continues to **90***g*. The program flow may also continue from **90***f* to **90***g*. At **90***g* a decision is made whether counter b has reached zero, in which case the lines left in set B (which number may be equal to zero) are deemed necessary for unique determination of the coordinates of all the points in set P. If the decision at **90***g* is positive, program flow continues to **90***h*. If the decision at **90***g* is negative, program flow reverts to **90***d*.

During **90***h*, line A(a) is removed from set A, after which counter a is decremented by 1. Program flow then continues to **90***i*, where a decision is made whether complete 3D information on the lines in sets A and B, together with the a priori information, constitute enough information to uniquely determine the coordinates of all the points in set P.

If the decision at **90***i* is negative, program flow continues to step **90***j*, where line A(a+1) is added once more to set A.

If the decision at **90***i* is positive, program flow continues to step **90***k*. The program flow also continues from **90***j* to **90***k*. At **90***k*, a decision is made whether counter a has reached zero, in which case the lines left in set A (which number may be equal to zero) are deemed necessary for unique determination of the coordinates of all the points in set P. If the decision at **90***k* is negative, program flow reverts to **90***h*. If the decision at **90***k* is positive, program flow continues to **90***m*, the details of which are described with reference to FIG. **5**.

In FIG. **5**, the program continues to **100***a*, where counter p is initialized to 1 and variable n is set to the number of points in set P.

Program flow then continues to **100***b* where a decision is made whether line A(p) (connecting point CA to point C(p) is included in set A. If the decision is negative, program flow continues to **100***c*, where counter p is incremented by 1.

If the decision at 10 Gb is positive, program flow continues to **100***e*, at which the program identifies point C(p) to the user and then can query the user to highlight this point using light-beam projection device **202**, preferably from a position such as point CA, as determined previously at **90***a* (FIG. **4**). The user can also be queried to affirm the highlighting action by, for example, activating one of the buttons **203***a* or **204***b*, or the like. The identification of point C(p) may occur, for example, by having the program display a visible screen mark **521***a*-**521***d* at a position on computer screen interaction region **51** associated with C(p), which may then be projected by projection device **40** to coincide with point C(p). Other means of identification are also possible, such as the characterization of point C(p) as ‘upper-right corner’ or the like.

Program flow then continues on to **100***f*, where the program can wait until the highlighting action is affirmed by the user, after which the 3D orientation of the z'-axis and the 3D position of the z'=0 point (of the z'-axis) are measured with respect to the x y z coordinate system, using coordinate sensing device **201** and **301**, and communicated to the computer using communication and control device **204** and/or **304**. This 3D orientation and position is then associated with line A(p) and stored in memory. Program flow then continues to **100***c*.

After **100***c* program flow continues to **100***d* where a decision is made whether p is equal to n+1. If the decision is positive, it can be concluded that all necessary data on lines A(p) have been ascertained and program flow can continue to **100***g*. If the decision at **100***d* is negative, program flow reverts to **100***b*.

At **100***g* a decision is made whether set B is empty. If the decision is positive, it can be concluded that enough information to uniquely determine the 3D coordinates of all the points in set P is contained in the a priori relationships combined with the available data on the lines in set A, and program flow continues to **100***p*. If the decision at **100***g* is negative, program flow continues to **100***h*.

At **100***h* counter p is again initialized to 1. The user is subsequently required to reposition the pointing device **20** to a different location, displacing it substantially parallel to projection region **60** over a distance substantially equal to the distance between projection region **60** and his or her present location. Other locations may also be used.

Flow then continues to **100***i* where a decision is made whether line B(p) (connecting point CB to point C(p)) is included in set B. If the decision is negative, program flow continues to **100***j* where counter p is incremented by 1.

If the decision at **100***i* is positive, program flow continues to **100***m*, at which point the program identifies point C(p) to the user and can query the user to highlight this point using light-beam projection device **202**. The program can also query the user to affirm the highlighting by, for example, activating one of the buttons **203***a* or **204***b* or the like. The identification of point C(p) may occur, for example, by having the program display a visible screen mark **521***a*, **521***b*, . . . at a position on computer screen interaction region **51** associated with CO, which may then be projected by projection device **40** to coincide with point C(p). Other means of identification are also possible, such as the characterization of point C(p) as 'upper-right corner' or the like.

Program flow then continues to **100***n*, where the program may wait until the highlighting action is affirmed. After affirmation, the 3D orientation of the z'-axis and the 3D position of the point z'=0 (of the z'-axis) are measured with respect to the x y z coordinate system, using coordinate sensing device **201** and **301**, and are communicated to the program using communication and control device **204** and/or **304**. The 3D orientation and position are then associated with line B(p) and can be stored in memory. Program flow then continues to **100***j*.

After **100***j* program flow continues to **100***k* where a decision is made whether p is equal to n+1. If the decision is positive, it is concluded that all necessary data for lines B(P) has been ascertained and program flow continues to **100***p*. If the decision is negative, program flow reverts to **100***i*.

At **100***p* it is concluded that the combined information of the a priori relationships and the data for lines in sets A and B that is stored in memory is enough to establish the coordinates of all points in P, as is further explained with reference to FIG. **6**.

Referring to FIG. **6**, as will be appreciated by those skilled in the art, at **110***a* the available information contained in the a priori relationships and the orientations and positions of the lines in sets A and B may be used to establish the coordinates of each of the points in set P, all measured with respect to the x y z coordinate system. It may happen that the 3D data associated with lines A(p) and B(p) ($1<p<n+1$) cause them not to intersect at point C(p); for example, this could be the case due to insufficient accuracy in determining the orientations and positions of lines A(p) and B(p). Under such circumstances point C(p) may be estimated or determined in such a way that it lies halfway along the shortest line-segment that connects lines A(p) and B(p). Other methods for determining point C(p) are also possible.

Once the complete 3D description of interaction structure **72** has been established (given the available data and assumptions), program flow continues to **110***b*. At **110***b*, a method M is constructed that maps points of interaction structure **72** to computer screen interaction region **51**. Such methods are well known to those skilled in the art. For example, a method such as that described in U.S. Pat. No. 6,373,961 to Richardson et al. (2002) may be used, but other appropriate methods may also be used. For completeness, the method disclosed in the Richardson et al. '961 patent will briefly be explained here. Referring to FIG. **20**, interaction structure **72** may be defined by line segments JK and ML. Furthermore, point F may define point-of-aim **210**, which is also the intersection between the z'-axis and interaction structure **72**. The line segments JK and ML are generally not parallel. If not parallel, then the line segments JK, ML are extended until they meet at a point H. Then a line is drawn through F and H, that intersects segment JM at point P and segment KL at point O. If the segments JK. and ML are parallel, the a line is drawn instead through F that is parallel to JK, and which intersects the other two line segments as described. The process continues similarly with the other segments, which are extended to meet at point G. A line through F and G intersects segment JK at point R and segment ML at point Q. Subsequently, the following distances are measured and noted as percentages: JR/JK, KO/KL, LQ/LM and MP/MJ. Then four points S, T, U, V are chosen as shown in FIG. **20**, that form an exact rectangle STUV; this rectangle may define computer screen interaction region **51**. Further, points W, X, Y, Z are chosen on the sides of the rectangle STUV in such a way that SZ/ST=JR/JK, TW/TU=KOIKL, UX/UV=LQ/LM and VY/VS=MP/MJ. Then the points Z and X are joined by a line, and the points Y and W are joined by a line. The point of the intersection of these latter two lines is N, which is the point that results from the operation of method M.

Referring once again to FIG. **6**, after **110***b*, program flow continues to **110***c* where a decision is made whether the user has requested the program to end. If the decision is positive, the program ends at **110***k*.

If the decision at **110***c* is negative, program flow continues to **110***d*, where a decision is made regarding whether the user has requested a direct-pointing action, such as activating button **203***a* or **203***b* or the like.

If the decision at **110***d* is negative, program flow continues to **110***e*, where the light-beam projection device **202** can be instructed or caused to de-activate (using, for example, control device **204** and/or **304**). Furthermore, a software routine (not shown) that controls computer cursor **501** (see also FIG. **2**) is instructed that the user does not want to execute a direct-pointing action, after which program flow reverts to **110***c*. Such cursor control routines are well known to those skilled in the art and are therefore not described here.

If the decision at **110***d* is positive, program flow continues to **110***f*, where a decision is made whether the z'-axis intersects interaction structure **72**. Those skilled in the art will appreciate that this is possible because all relevant 3D information is known or is measurable by coordinate sensing device **201** and **301**. If the decision is positive, program flow continues to **110***h*, at which method M is used to map the intersection point of the z'-axis with interaction structure **72** to computer screen interaction region **51**. This mapped position, as well as the user's desire to execute a direct-pointing action, are communicated to the cursor control routine (not shown) running on the computer.

After **110***h*, program flow continues to **110***i* where a decision is made whether the user wishes to execute an action associated with the position of cursor **501**. For example, activating button **203***a* or **203***b* or the like may indicate such a request. If the decision is negative, program flow reverts to **110***c*.

If the decision at **110***i* is positive, program flow continues to **110***j*, where the cursor control routine (not shown) is requested to execute the intended action. Such an action may, for instance, be a 'double-click' action or the like. Program flow then reverts to **110***c*.

There may be situations for which the system of equations that allows determination of all coordinates of the points in set P will be somewhat ill-posed. This could for example occur if locations CA and CB are chosen too close together, or if the angles of some pointing lines **21** with respect to interaction region **71** are too small, as will be appreciated by those skilled in the art. In such cases, the user may be directed to choose a

different point for locations CA and/or CB from where the various points C(p) are to be highlighted.

Thus, methods and means are disclosed that afford a highly flexible and easily deployable system for interacting with a presentation in a direct-pointing manner at a location not specifically designed or adapted for such a purpose. Moreover, although it is desirable to have highly accurate coordinate sensing device **201** and **301**, in some instances such may not be necessary because the visual feedback afforded by a displayed cursor will compensate to a large extent for any errors made in the measurements of coordinate parameters. The same holds true for the importance of any discrepancies between the actual shape of interaction region **71** and that of the interaction structure **72** that is assumed to coincide with it. Also, minor discrepancies between the actual position and orientation of interaction region **71** and the assumed position and orientation of interaction structure **72** (which is assumed to coincide with interaction region **71**) need not be of critical importance, as will be appreciated by those skilled in the art.

Mathematically, there are infinite possible shapes for interaction structure **72** as well as infinite a priori relationships, sets P, A, B and methods M. To further explain the invention, what follows is a list of examples that are believed will be encountered most often. These examples are not meant to restrict the scope of the present invention in any way, but merely serve as further clarification.

Referring to FIG. **7**, it can be assumed that the venue where the presentation is to be made is set up such that projection image **70** and interaction region **71** are substantially rectangular. Such may be the case when the optical axis of projection device **40** is substantially parallel to the normal to projection region **60**. Projection region **60** may be a projection screen on a stand, as shown, but may also be a wall or any other substantially vertical surface. It can also be assumed that the bottom and top edges of both projection image **70** and interaction region **71** are substantially horizontal. Furthermore, it can be assumed that interaction region **71** is substantially the same size as projection image **70** and that computer screen interaction region **51** is substantially the same size as computer screen image **50**. Additionally, it can be assumed that calibration points **721***a*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***d*. Finally, it is assumed that base station **30** is positioned such that the x-y plane is substantially horizontal and the x-z-plane substantially coincides with the plane of interaction region **71**. To facilitate in the positioning of base station **30**, the user may be aided by level-sensing device **303** and visible markings **302**.

Referring to FIGS. **3** and **7**, process elements **80***a-j* may then result, either through default settings or through user-supplied settings, in the assumptions that interaction structure **72** is a rectangle that lies in the x-z plane and that its top and bottom edges are parallel to the x-y plane.

Referring to FIGS. **4** and **7**, program element **90***a* may then result in a set P containing three points that define the upper-right corner C(**1**), the upper-left corner C(**2**) and the lower-left corner C(**3**) of interaction structure **72**. Additionally, program element **90***a* may determine point CA (not denoted as such in FIG. **7**) to lie away from projection region **60**, for example at the center of one of the two instantiations of pointing device **20**, as shown in FIG. **7**. Point CB may be determined anywhere in space. Program element **90***a* may also result in sets A and B each containing three lines, connecting the points in set P to points CA and CB respectively. Program element **90***c* may then result in a priori relationships such that all points in set P have y-coordinate equal to zero, that the upper-left corner will have an x-coordinate equal to the x-coordinate of the lower-left corner and that its z-coordinate will be equal to

the z-coordinate of the upper-right corner. It will then be appreciated by those skilled in the art that this a priori information, together with complete 3D information on two lines in set A will be sufficient to uniquely determine the position, size and orientation of interaction structure **72** with respect to the x y z coordinate system. Therefore, program elements **90***d*, **90***e*, **90***f*, **90***g* may result in an empty set B. Moreover, program elements **90***b*, **90***i*, **90***j*, **90***k* may result in the removal from set A of line A(**2**), connecting point CA to point C(**2**).

Referring to FIGS. **5** and **7**, program elements **100***a-p* may result in the program identifying point C(**1**) by instructing the computer (not shown) and projection device **40** to project screen mark **521***a* onto projection region **60**, resulting in the appearance of calibration point **721***a*. Subsequently, the user is required to use light-beam projection device **202** to highlight calibration point **721***a* and indicate the success of this action to the computer (not shown) by, for example, pressing button **203***a*. As a result, the orientation and position of the z'-axis are assumed to define line A(**1**). The same actions are then performed for point C(**3**) and line A(**3**). Since set B is empty, the user need not be required to reposition pointing device **20**. The two depictions of pointing device **20** in FIG. **7** are meant to illustrate that pointing device **20** only needs to be redirected and not repositioned during this exercise. It will be appreciated by those skilled in the art that program element **1OOp** will then successfully result in a full 3D description of the three points in set P.

Referring to FIGS. **6** and **7**, program element **110***a* may then result in the description of interaction structure **72** as a rectangle with upper-right corner C(I), upper-left corner C(**2**) and lower-left corner C(**3**). Step **110***b* may then result in a method M that maps a point δ (not shown) in interaction structure **72** to a point ϵ (not shown) in computer screen interaction region **51** in such a way that the ratio of distances between δ and any two of the four corners of interaction structure **72** is the same as the ratio of distances between ϵ and the two corresponding corners of computer screen interaction region **51**, as will be appreciated by those skilled in the art. Steps **110***c-k* may then result in a very intuitive cursor control device that responds to a direct-pointing action by deactivating light-beam projection device **202** and showing cursor **501** at substantially point-of-aim **210** of pointing device **20** whenever point-of-aim **210** lies in projection image **70** (which in this example, by assumption, substantially coincides with interaction region **71**). Since there is no necessity for a computer generated cursor and a light spot to be visible simultaneously there will not be any cause for confusion as to which of the two is the ‘actual cursor’. Cursor **501** may be hidden from view when point-of-aim **210** does not lie in interaction structure **72**, in which case light-beam projection device **202** may be activated automatically. Also, intuitive actions such as ‘double click’ may be provided by steps **110***c-k*.

Referring to FIG. **8**, it can be assumed that the venue where the presentation is to be given is set up such that projection image **70** and interaction region **71** are substantially rectangular. Such may be the case when the optical axis of projection device **40** is substantially parallel to the normal to projection region **60**. Projection region **60** may be a projection screen on a stand, as shown, but may also be a wall or any similar surface. Projection region **60** can be assumed to be oriented substantially vertically. It can also be assumed that the bottom and top edges of both projection image **70** and interaction region **71** are substantially horizontal. Furthermore, it can also be assumed that interaction region **71** is substantially the same size as projection image **70** and that computer screen interaction region **51** is substantially the same size as computer screen image **50**. Additionally, it can

be assumed that calibration points **721***a*, **721***c*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***c*, **521***d*. Finally, it can be assumed that base station **30** is positioned such that the x-y-plane is substantially horizontal. No assumptions are made regarding the x-z-plane and the y-z plane other than that they are substantially vertical. To facilitate in the positioning of base station **30**, the user may be aided by level-sensing device **303**.

Referring to FIGS. **3** and **8**, program elements **80***a-j* may then result, either through default settings or user-supplied settings, in the assumptions that interaction structure **72** is a rectangle of which the top and bottom edges are parallel to the x-y-plane (i.e., they are horizontal) and the left and right .edges are perpendicular to the x-y-plane (i.e., they are vertical).

Referring to FIGS. **4** and **8**, program element **90***a* may then result in a set P containing three points that define the upper-left corner C(**1**), the upper-right corner C(**2**) and the lower-left corner C(**3**) of interaction structure **72**. Additionally, program element **90***a* may determine point CA (not denoted as such in FIG. **8**) to lie away from projection region **60**, for example, at the center of one of the three instantiations of pointing device **20**, as shown in FIG. **8**. Point CB (not denoted as such in FIG. **8**) may be determined to be displaced from point CA in a direction substantially parallel to interaction region **71**, over a distance that may be the same order of magnitude as the size of interaction region **71**. Program element **90***a* may also result in sets A and B each containing three lines, connecting the points in set P to points CA and CB respectively. Program element **90***c* may then result in a priori relationships requiring that the upper-left corner will have x- and y-coordinates equal to the x- and y-coordinates of the lower-left corner and that its z-coordinate will be equal to the z-coordinate of the upper-right corner. As will be explained in detail below, the a priori information together with complete 3D information on two lines in set A and one line in set B will be enough to uniquely determine the position, size and orientation of interaction structure **72** with respect to the x y z coordinate system. Therefore, program elements **90***d*, **90***e*, **90***f*, **90***g* may result in set B containing only line B(**3**). Moreover, program elements **90***h*, **90***i*, **90***j*, **90***k* may result in set A containing only lines A(**1**) and A(**2**)

Referring to FIGS. **5** and **8**, program elements **100***a-p* may result in the program identifying point C(**1**), C(**2**) and C(**3**) by means of projection device **40**, in a manner similar to the one described in the previous example. In this case, however, C(**1**) and C(**2**) may be highlighted from approximately the same location CA, but C(**3**) needs to be highlighted from a different location CB. To explain that the above-mentioned information is enough to uniquely establish the position, size and orientation of interaction structure **72**, define the points in set P as:

$$C(1) = \begin{pmatrix} x_1 + \lambda_1 \cdot Rx_1 \\ y_1 + \lambda_1 \cdot Ry_1 \\ z_1 + \lambda_1 \cdot Rz_1 \end{pmatrix} \quad (1)$$

$$C(2) = \begin{pmatrix} x_1 + \lambda_2 \cdot Rx_2 \\ y_1 + \lambda_2 \cdot Ry_2 \\ z_1 + \lambda_2 \cdot Rz_2 \end{pmatrix} \quad (2)$$

$$C(3) = \begin{pmatrix} x_1 + \lambda_3 \cdot Rx_3 \\ y_1 + \lambda_3 \cdot Ry_3 \\ z_1 + \lambda_3 \cdot Rz_3 \end{pmatrix} \quad (3)$$

Here, points CA and CB are defined as (x**1**, y**1**, z**1**) and (x**3**, y**3**, z**3**) respectively. Moreover, lines A(**1**), A(**2**) and B(**3**) are defined as passing through CA, CA and CB respectively, lying in directions governed by (Rx**1**, Ry**1**, Rz**1**), (Rx**2**, Ry**2**, Rz**2**) and (Rx**3**, Ry**3**, Rz**3**). All of these quantities are presumed to be measured by coordinate sensing device **201** and **301**. For a unique description of the points in set P a solution is required for λ**1**, λ**2** and λ**3**.

Using these definitions the conditions described above can be written as:

$$\begin{bmatrix} Rz_1 & -Rz_2 & 0 \\ Rx_1 & 0 & -Rx_3 \\ Ry_1 & 0 & -Ry_3 \end{bmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} 0 \\ x_3 - x_1 \\ y_3 - y_1 \end{pmatrix} \quad (4)$$

which can be solved in a straightforward manner according to the expression:

$$\begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} [Rx_3 \cdot (y_3 - y_1) + Ry_3 \cdot (x_1 - x_3)] / [Rx_3 \cdot Ry_1 - Rx_1 \cdot Ry_3] \\ \left[\frac{Rz_1}{Rz_2}\right] \cdot [Rx_3 \cdot (y_3 - y_1) + Ry_3 \cdot (x_1 - x_3)] \Big/ \left[\begin{matrix} Rx_3 \cdot Ry_1 - \\ Rx_1 \cdot Ry_3 \end{matrix}\right] \\ [Rx_1 \cdot (y_3 - y_1) + Ry_1 \cdot (x_1 - x_3)] / [Rx_3 \cdot Ry_1 - Rx_1 \cdot Ry_3] \end{pmatrix} \quad (5)$$

Note that this solution shows that, if point C(**3**) was highlighted from any point on the pointing line **21** that is used to highlight point C(**1**), i.e.,

$$\begin{pmatrix} x_3 \\ y_3 \\ z_3 \end{pmatrix} = \begin{pmatrix} x_1 + \tau \cdot Rx_1 \\ y_1 + \tau \cdot Ry_1 \\ z_1 + \tau \cdot Rz_1 \end{pmatrix} \quad (6)$$

the solution for the three unknown λ's would collapse to

$$\begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} \tau \\ \tau Rz_1 / Rz_2 \\ 0 \end{pmatrix} \quad (7)$$

making unique determination of interaction structure **72** impossible. Conversely, the fact that points C(**1**) and C(**2**) are, in this example, both highlighted from substantially the same point CA does not cause any problems. It will be appreciated by those skilled in the art that C(**1**) and C(**2**) may also be highlighted from different points, without loss of functionality.

Referring to FIGS. **6** and **8**, the course and results of program elements **110***a-k* will be similar to those described in Example 1.

Referring to FIG. **9**, in another example, the only assumptions made are that interaction region **71** is substantially the same size as projection image **70**, computer screen interaction region **51** is substantially the same size as computer screen image **50**, calibration points **721***a*, **721***b*, **721***c*, **721***d* substantially coincide with the projected versions of screen marks **521***a*, **521***b*, **521***c* and **521***d* and computer screen interaction region **51** is substantially rectangular. This situation may arise when the optical axis of projection device **40** is not aligned with the normal to projection surface **60**.

Referring to FIGS. **3** and **9**, program elements **80***a-j* may then result, either through default settings or user supplied

settings, in the assumption that interaction structure **72** is a quadrangle; no assumptions are made regarding its position or orientation.

Referring to FIGS. **4** and **9**, program elements **90***a* may then result in a set P containing four points that define the upper-right, upper-left, lower-right and lower-left corners of interaction structure **72**. Additionally, program element **90***a* may conceive point CA (not denoted as such in FIG. **9**) to lie away from projection region **60**, for example at the center of the first of the two instantiations of pointing device **20**, as shown in FIG. **9**. Point CB may, for example, be determined to lie at the center of the second of the two instantiations of pointing device **20**, as drawn in FIG. **9**. Now, program elements **90***d*, **90***e*, **90***f*, **90***g* and steps **90***h*, **90***i*, **90***j*, **90***k* may result in sets A and B each containing 4 lines.

Referring to FIGS. **5** and **9**, program elements **100***a-p* may result in the program identifying the four points in set P by means of projection device **40**, in a manner similar to the one described in Example 1. In this case, however, all four points in set P may be highlighted from approximately the same location CA first, after which all four points may be highlighted from approximately the same location CB. Note that FIG. **9**, for reasons of clarity, only depicts the highlighting of calibration point **721***a*. Each point C(i) may then be constructed as the point lying halfway the shortest line segment connecting lines A(i) and B(i); this line segment may have zero length.

Referring to FIGS. **6** and **9**, the course and results of program elements **110***a-k* will be similar to those described with respect to the first example, with the exception of program element **110***b*, the mapping element. Now, a more elaborate method M is needed than the one described in previous examples. For example, a method such as described in U.S. Pat. No. 6,373,961 to Richardson (2002) may be utilized, but other appropriate methods may also be used.

A second embodiment will now be made with reference to FIG. **10**, which shows pointing device **20** and base station **30**. Here, in addition to any or all of the elements mentioned in the previous embodiment, pointing device **20** is also provided with distance measuring device **206**, the position and orientation of which with respect to the x' y' z' coordinate system may be ascertained at the place of manufacture thereof and will be presumed to be known. Distance measuring device **206** may for example be embodied by a focus adjustment, or optical sensor. A digital camera may also be used. Distance measuring device **206** may determine the point-of-aim-distance **211** between the origin of the x' y' z' coordinate system and the point-of-aim, measured substantially parallel to the z'-axis (see also FIG. **2**). The point of aim **210** may lie on projection region **60**, on which interaction region **71** may lie. Distance measuring device **206** may have associated with it a manual focus adjustment that may be adjusted by the user (manual focus adjustment not shown). Alternatively, distance measuring device **206** may comprise a circuit (not shown) that automatically determines the point-of-aim-distance **211** between the origin of the x' y' z' coordinate system and the point-of-aim. For example, if the point-of-aim lies on projection region **60**, distance measuring device **206** may bounce light off of projection region **60**. In doing so, use may for instance be made of light-beam projection device **202**. Any other appropriate mechanism for determining distance may also be used for distance measuring device **206**. The optical axes of light-beam projection device **202** and distance measuring device **206** may coincide, for instance by making use of partially-reflecting elements (not shown) such as disclosed in U.S. Pat. No. 4,768,028 to Blackie (1988).

The operation of the present embodiment will now be described with reference to FIGS. **2**, **10**, and **3**. The process elements in FIG. **3** will be identical to the ones described in the first embodiment, resulting in similar assumptions regarding the shape of interaction region **71** (and interaction structure **72**) and possibly orientation and position of interaction structure **72**.

Referring to FIG. **11**, instead of the program elements described above with reference to FIG. **4**, program flow now continues at **120***a*. Program elements **120***a*-**120***h* are shown to be similar to program elements **90***a*-**90***m* (FIG. **4**), except that only point CA, set A and counter a are considered. That is to say, in the present embodiment it is no longer necessary to determine the second point CB and associated repositioning of pointing device **20** during the calibration procedure.

After program element **120***h*, program flow continues with program elements outlined in FIG. **12**. Referring to FIG. **12**, program elements **130***a*-**130***g* are seen to be similar to steps **100***a*-**100***p* (FIG. **5**). Comparing program element **130***f* with program element **100***f* (FIG. **5**), it can be seen that at **130***f* the program also stores information on the point-of-aim-distance (**211** in FIG. **2**) between the origin of the x' y' z' coordinate system and point C(p). Comparing elements **130***g* and **100***p* (FIG. **5**), it can seen that these point-of-aim-distances (**211** in FIG. **2**) are also used in determining the 3D coordinates of the points in set P.

With complete information on the 3D coordinates of the points in set P, it is then possible to construct a 3D description of interaction structure **72** (in FIG. **2**). Therefore, program elements **110***a*-**110***k* as described above with reference to FIG. **6** may also be followed in the present embodiment.

Thus, methods and means are disclosed that afford a highly flexible and easily deployable system for interacting with a presentation in a direct-pointing manner at a location not specifically equipped for such a purpose. Moreover, when utilizing the second preferred embodiment it is often sufficient for the user to highlight various calibration points **721***a*, **721***b*, . . . from one and the same position, making the calibration procedure even more easy to follow.

Another embodiment will now be explained with reference to FIG. **13**. FIG. **13** shows another embodiment of the pointing device **20**. Pointing device **20** may be equipped with any or all of the elements mentioned in the other embodiments, such as described above with reference to FIG. **1** and FIG. **10**. The present embodiment may include a base station **30** that has associated with it a coordinate system x y z. However, in the present embodiment it can be assumed that the position of pointing device **20** will remain substantially unchanged relative to interaction region **71** over an extended period of time, and that the origin of coordinate system x y z may be assumed to be virtually anywhere instead of being related to the base station **30**. Furthermore, if any of the axes of the x y z system are chosen to be related to locally well-established, independent and stationary directions such as, for example, the Earth's magnetic field and/or the Earth's gravitational field, the Earth itself may be interpreted as embodying base station **30**. Under such circumstances there may not be a need for an artificial base station **30**; coordinate sensing device **201** may then, for example, be embodied by devices sensing the directions of the Earth magnetic and gravitational fields, such as accelerometers and a compass (for example, model no. HMR3300 device as manufactured by Honeywell International Inc., Morristown, N.J.), and communication and control device **204** may be configured to communicate directly with the computer (not shown).

The operation of the present embodiment will now be described with reference to FIGS. **8**, **13**, and **3**. The remainder

of the description of the present embodiment will, for purposes of explanation, include the assumption that any separately embodied base station **30** (FIGS. **8** and **13**) is omitted entirely. It is also assumed that one of the axes of the orthogonal coordinate system x y z is substantially parallel to the Earth's gravity field (or has a defined relationship thereto), while the second and third axes of the coordinate system are in a fixed, known relationship to the at least one geographically defined axis. In the present embodiment it is assumed that the relative position of pointing device **20** with respect to interaction region **71** remains substantially unchanged, therefore the origin of coordinate system x y z will, for purposes of explanation, be chosen to coincide with a fixed point in the pointing device **20**. For the purpose of the present embodiment, it should be understood that the three instantiations of pointing device **20** as shown in FIG. **8** substantially coincide.

It can be assumed in the present embodiment that a display system is arranged at the venue where a presentation is to be made, as a combination of a portable projection device **40** and projection surface **60**, for example a wall. It will furthermore be assumed that this display system is connected, using appropriate means, to the computer (not shown) that generates the

Upon arriving at the venue, the user connects pointing device **20** to the computer (not shown), for example via a USB connection (not shown), or using a wireless relay device (not shown). Also, the computer may recognize the connection and start a program, part of which may be contained in communication and control device **204** or in control logic contained in the wireless relay device itself (not shown). Alternatively, the user may be required to load the program into the computer manually via a CD drive, a floppy drive, memory stick or the like (not shown). In any case, the program may initiate a calibration routine that has as its object establishing the shape, position, size and orientation of a well-defined interaction structure **72**, relative to the x y z coordinate system, wherein the interaction structure **72** is assumed to substantially coincide with a scaled and parallel version of interaction region **71**. The flow of this program will be explained with reference to FIG. **3**.

At **80***a* the program is initiated. At **80***b* defaults are entered for interaction region **71**. Specifically, interaction region **71** is assumed to be a substantially parallel and scaled version of a well-defined interaction structure **72**. Moreover, the respective corners of interaction region **71** and interaction structure **72** are assumed to substantially lie on lines intersecting each other in the origin of coordinate system x y z. It should be noted that FIG. **8** shows an interaction region **71** and an interaction structure **72** that are almost coincident, but this is only meant for illustrative purposes and is not a limitation on the scope of the invention. Again referring to FIG. **3**, at **80***b* default values are also established for the orientation and position of the interaction structure **72**. For example, the default values may provide that interaction region **71** is substantially a parallel and scaled version of an interaction structure **72** that is a flat rectangle of which the two most vertical sides are substantially parallel to the Earth's gravitational field, and of which the two most horizontal sides are substantially perpendicular to the Earth's gravitational field; moreover, the default values may provide that the respective corners of interaction region **71** and interaction structure **72** substantially lie on lines intersecting each other in the origin of coordinate system x y z. The default values may furthermore provide that the position of interaction structure **72** is such that the distance between pointing device **20** and the lower left corner of interaction structure **72** is equal to 1. Note that other values for the foregoing distance may be equally

valid in the present embodiment. Based on the foregoing default values, calibration points **721***a*, **721***c*, **721***d*, . . . can define characteristic features of interaction region **71** and can also define characteristic features of interaction structure **72**.

At **80***c* a decision is made whether the default values for interaction region **71** and interaction structure **72** should be accepted or overridden by the user. If the default values are to be accepted, the program flow continues to **80***j*, the details of which are explained below with reference to FIG. **11**. If the defaults are to be overridden, the program flow continues with elements **80***d*-**80***i*, during which the user may override any of the default settings. The user may be aided during program elements **80***d*-**80***i* by a library of predetermined shapes, predetermined orientations and/or predetermined positions. Alternatively, the user can be provided with the capability to construct custom shapes, orientations and/or positions. In any event, program flow continues to **80***j*.

Referring to FIG. **11**, program flow now continues to **120***a*. Program elements **120***a*-**120***h* are substantially similar to program elements **90***a*-**90***m* (FIG. **4**), except that only point CA, set A and counter a . . . are considered. In the present embodiment it is not required to determine a second point CB and an associated repositioning of pointing device **20** during the calibration procedure.

After **120***h*, program flow continues with elements described with reference to FIG. **14**. In FIG. **14**, program elements **140***a*-I**40***g* are shown to be similar to steps **130***a*-**130***g* (FIG. **12**). Comparing element **140***f* with element B of (FIG. **12**), it can be seen that element **140***f* does not include storing information for any directly measured distance. Element **140***f* need not include storing information on the position of the z'-axis, because the position of pointing device **20** is assumed to remain substantially unchanged over an extended period of time. Comparing elements **140***g* and BOg, it can be seen that any directly measured distance is not needed to determine the 3D coordinates of the points in set P (see FIG. **4**). In fact, having the default distance (set to 1) between pointing device **20** and the lower left corner of interaction structure **72** is sufficient for operation of the system in the present embodiment. To explain this fact, reference is again made to FIG. **8**. Using the above default values, interaction structure **72** will be completely defined by, for example, its upper-left corner C(**1**), its upper-right corner C(**2**) and its lower-left corner C(**3**)

$$C(1) = \lambda_1 \cdot \begin{pmatrix} Rx_1 \\ Ry_1 \\ Rz_1 \end{pmatrix} \tag{8}$$

$$C(2) = \lambda_2 \cdot \begin{pmatrix} Rx_2 \\ Ry_2 \\ Rz_2 \end{pmatrix} \tag{9}$$

$$C(3) = \lambda_3 \cdot \begin{pmatrix} Rx_3 \\ Ry_3 \\ Rz_3 \end{pmatrix} \tag{10}$$

lying on lines A(**1**), A(**2**) and A(**3**) that connect the origin to points (Rx**1**, Ry**1**, Rz**1**), (Rx**2**, Ry**2**, Rz**2**) and (Rx**3**, Ry**3**, Rz**3**) respectively. Using these definitions, the conditions described above determine relationships between the various variables that can be written as

$$\begin{bmatrix} Rz_1 & -Rz_2 & 0 \\ Rx_1 & 0 & -Rx_3 \\ Ry_1 & 0 & -Ry_3 \end{bmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \tag{12}$$

which will have non-trivial solutions only if the determinant of the matrix equals zero. Then, it can be shown that any combination of (λ**1**, λ**2**, λ**3**) that can be written in the form:

$$\begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} Rz_2 / Rz_1 \\ 1 \\ (Rz_2 \cdot Rx_1)/(Rz_1 \cdot Rx_3) \end{pmatrix} \cdot \alpha \tag{13}$$

where α is any arbitrary real number, will generate solutions for interaction structure **72** that are parallel to each other. The assumption that the distance between pointing device **20** and the lower left corner of interaction structure **72** is 1 will hence uniquely generate one of these solutions. To see that other assumptions regarding this distance do not influence the operation of the present embodiment, reference is made to FIG. **15**. In FIG. **15**, projections of two parallel solutions for interaction structure **72** are shown, obtained for different values of distances CA-C(**3**). When it is assumed, for purposes of explanation, that these two solutions are parallel to the z-x plane, FIG. **15** may be interpreted as a projection of the two solutions onto the x-y plane. These projections are shown as the thick line segments C(**3**)-C(**2**) and CC**3**-CC**2**. FIG. **15** also shows the projection of point CA (i.e., the origin of coordinate system x y z), from where the lower left and upper right corners of interaction structure **72** were highlighted, and line-segments C(**3**)-CA and C(**2**)-CA which coincide with the (projections of) the highlighting lines A(**3**) and A(**2**) (not denoted as such in FIG. **15**). Finally, line-segment BB**1**-CA indicates (the projection of) a pointing line that is consistent with a point-of-aim BB**1** on the one and point-of-aim BB**2** on the other of the two solutions for interaction structure **72**. To show that BBI and BB**2** represent the same horizontal coordinate when measured relative to the appropriate solution for interaction structure **72**, the lengths of line segments C(**3**)-BB**1**, C(**2**)-BB**1**, CC**3**-BB**2**, CC**2**-BB**2**, BB**1**-CA and BB**2**-CA are represented by bb**1**, bb**2**, b**1**, b**2**, aa**12** and a**12**, respectively. It is sufficient to show that bb**1**/bb**2**=b**1**/b**2**. Consider the following equalities:

$$\frac{bb1}{\sin\beta 1} = \frac{aa12}{\sin\alpha 1} \tag{14}$$

$$\frac{bb2}{\sin\beta 2} = \frac{aa12}{\sin\alpha 2} \tag{15}$$

while, at the same time

$$\frac{b1}{\sin\beta 1} = \frac{a12}{\sin\alpha 1} \tag{16}$$

$$\frac{b2}{\sin\beta 2} = \frac{a12}{\sin\alpha 2} \tag{17}$$

From this it follows that

$$\frac{aa12}{bb1} = \frac{a12}{b1} \tag{18}$$

$$\frac{aa12}{bb2} = \frac{a12}{b2} \tag{19}$$

which, in turn, provides that

$$bb1\frac{a12}{b1} = bb2\frac{a12}{b2} \Rightarrow \frac{bb1}{bb2} = \frac{b1}{b2} \tag{20}$$

This implies that BB**1** and BB**2** represent the same horizontal coordinate when measured relative to the appropriate solution for interaction structure **72**. Note that, if FIG. **15** is interpreted as a projection onto the z-y-plane, it can be concluded that BB**1** and BB**2** also represent the same vertical coordinate when measured relative to the appropriate solution of interaction structure **72**. Therefore the initial assumption that the distance between C(**3**) and CA is equal to 1 does not influence the operation of the third preferred embodiment.

It is theoretically possible that there are no non-zero solutions for the parameters λ**1**, λ**2** and λ**3** when the determinant referred to above in equation (12) is non-zero. Such may be the case, for example, due to errors in measurements or in the assumed rectangular shape of interaction region **71**. In such cases additional techniques may be used to find an acceptable solution for interaction structure **72**. For example, a minimization routine may be used to find a solution for interaction structure **72** that minimizes a summation of the distances between some of its corners (which, by assumption, lie on lines connecting the origin of coordinate system x y z with the corners of interaction region **71**) and the highlighting lines.

With complete information on the 3D coordinates of C(**1**), C(**2**) and C(**3**) it is possible to construct a 3D description of interaction structure **72**. Therefore, program elements **110***a*-**110***k* as described in the first embodiment and explained above with reference to FIG. **6** may also be followed in the present embodiment.

There may be situations in which the user is not able to hold pointing device **20** continuously at precisely the same position while performing the actions required by the calibration procedure described in FIGS. **3**, **11** and **14**, or during the use of the system as a direct-pointing device. Such changes in position of the pointing device **20** can cause errors in the calculation of the point-of-aim. It will be appreciated that if the discrepancy between the calculated and the true point-of-aim is small enough, the visual feedback provided by the displayed cursor (**501** in FIG. I) during use of the system as a direct-pointing device will still afford the user the perception that direct-pointing is being performed.

There are many other methods capable of establishing position, size and orientation of interaction structure **72**, as will be appreciated by those skilled in the art. For example, if the distance between pointing device **20** and interaction structure **72** is presumed known, if interaction structure **72** is assumed to be rectangular with two vertical and two horizontal sides and if its aspect ratio (the ratio between its horizontal size and its vertical size) is also presumed known, then knowledge of two lines from CA to the upper-right and lower-left corner is sufficient to narrow the number of solutions for interaction structure **72** down to 2, dictated by 2 solutions of a quadratic equation. One further assumption is then required to determine which of these 2 solutions is the correct one; this assumption may be in the form of a third line passing through

yet another characteristic point of interaction structure **72**, but it may also be in the form of knowledge of the (approximate) angle between the plane in which interaction structure **72** lies and a line connecting the origin to one of its corners. Other scenarios may also be conceived for which solutions may be devised that are within the scope of the general methods set forth herein.

In the present embodiment, using well-established and stationary directions such as, for example, the Earth's magnetic field and the Earth's gravitational field, it may be possible to omit a separately embodied base station, making the present embodiment of the system possibly more compact, less expensive to make and easier to deploy.

Another embodiment of a system according to the invention will now be described with reference to FIG. **16**. In the present embodiment a handheld presentation device **25** contains a power source **205**, communication and control device **204** and a directional sound recording device **251**. The sensitivity region of the directional sound recording device **251** may be substantially oriented along the long axis of presentation device **25**. Any or all of the features contained in pointing device **20**, already described in previous embodiments or to-be-described in the additional embodiments, may also be contained in presentation device **25**; any or all of features **201**-**207** are collectively depicted as module **200**. In the same way, the fourth preferred embodiment also may but need not provide base station **30** and its associated elements, such as elements **301**-**305** or a wireless relay device (not shown in FIG. **16**).

The directional sound recording device **251** may be provided with so-called zoom capabilities, such as those afforded by, for example, the ECM-Z60 Super Zoom Microphone as manufactured by Sony. Alternatively, directional sound recording device **251** may comprise multiple directional microphones (not shown) with different sensitivity regions, so that zoom 'capabilities may be emulated. In these cases, presentation device **25** may also be provided with zoom control device **252**, capable of adjusting the sensitive volume of directional sound recording device **251** either by manual control or automatically. Directional sound recording device **251** may communicate with the computer (not shown) and/or base station **30** (not shown in FIG. **16**) through communication and control device **204** and/or **304** (not shown in FIG. **16**). A control program described in FIG. **17** may be transferred to the computer (not shown) or be incorporated in communication and control device **204** and/or **304**. Moreover, there may be provided a storage medium for storage of sound data (not shown) in one of the components of the described system, as well as means to play back sound, such as a loudspeaker (not shown).

During a presentation it may occur that a member of the audience wishes to communicate verbally with the presenter (user). Often, the acoustics of the room preclude other members of the audience from hearing such communication. In such cases, the user may point presentation device **25** in the direction of the member of the audience who wishes to communicate with the user. The user may then activate directional sound recording device **251** by activating controls such as button **203***a* or zoom control device **252**. The latter may also be used to acoustically zoom in on the particular member of the audience. Directional sound recording device **251** may then communicate with the computer (not shown) and record the communication, for example, in computer memory (not shown). At the same or later time the user may request the recording to be played back, for instance over speakers (not shown) driven by the computer (not shown), by activating controls such as button **203***b*. The computer program may be configured such that one and the same command from the user, such as the activation of button **203***a* or zoom control device **252**, initiates substantially simultaneous recording and playback. Measures to counteract any acoustical interference when playback and recording occur almost simultaneously may be implemented as well. Such measures are well known in the art.

Referring to FIG. **17**, to facilitate the recording and playback of sounds, general elements, **150***a*-**150***q* of a program are shown. These program elements may be executed by the computer (not shown), and may be loaded into the computer by such means as floppy discs, memory sticks or CDs (not shown). The programs may be pre-loaded in base station **30**, its associated wireless relay device (both not shown in FIG. **16**) or presentation device **25**, and transferred by means of a USB port or the like (not shown) upon connecting any of these components to the computer (not shown).

At **150***a* the program is initialized, old recordings are erased and a record-flag and a playback-flag are unset; this indicates that both recording and playback are not activated.

Program flow continues to **150***b*, where a decision is made whether the user requests the program to end. Buttons (**203***a*, **203***b* in FIG. **16**) or the like may be used for this purpose.

If the decision at **150***b* is positive, program flow continues to **150***q*, where any recording or playback is stopped, playback and record flags are unset, old recordings are erased and the program ends. If the decision at **150***b* is positive, program flow continues to **150***c*.

At **150***c* a decision is made whether the user has requested sound recording. If the decision is positive, program flow continues to **150***d*. If the' decision is negative, program flow continues on to **150***f*.

At **150***d* a decision is made whether the record-flag is unset, indicating that recording is not already in progress. If the decision is negative, program flow continues to **150***f*. If the decision is positive, program flow continues to **150***e*, where the record flag is set, any old recordings are erased and sound recording is started, after which the program flow continues to **150***f*.

At **150***f*, a decision is made whether the user has requested sound playback. If this decision is positive, program flow continues to **150***g*. If the decision is negative, program flow continues to **150***i*.

At **150***g* a decision is made regarding whether the playback flag is unset, indicating that playback is not already in progress. If the decision is negative, program flow continues to **150***i*. If the decision is positive, and there is some sound data to be played back, program flow continues to **150***h*, where the playback flag is set and sound playback is started, after which the program flow continues to **150***i*.

At **150***i* a decision is made whether the user has requested that sound recording is to be terminated. If the decision is positive, program flow continues to **150***j*. If the decision is negative, program flow continues on to step **150***m*.

At **150***j* a decision is made whether the record-flag has been set, indicating that recording is in progress. If the decision is negative, program flow continues to **150***m*. If the decision is positive, program flow continues to **150***k*, where the record flag is unset and sound recording is stopped, after which the program flow continues to **150***m*.

At **150***m* a decision is made whether the user has requested that sound playback is to be terminated. If the decision is positive, or if the end of the recorded sound has been reached, program flow continues to **150***n*. If the decision is negative, program flow reverts to step **150***b*.

At **150***n* a decision is made whether the playback flag has been set, indicating that playback is in progress. If the deci-

sion is negative, program flow reverts to **150***b*. If the decision is positive, program flow continues to **150***p*, where the playback flag is unset and sound playback is stopped, after which the program flow reverts to **150***b*.

Thus, methods and means are disclosed that afford a user the capability to easily capture and playback comments made by a member of the audience, even in the presence of substantial background noise.

While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, Many other variations are possible. For example, presentation device **25** or pointing device **20** may be hand held, but may also be carried by the user in a different manner, such as by means of a headset, finger worn ring or the like.

Although the first, second and third embodiments make use of the assumption that the interaction structure **72** and interaction region **71** are quadrangles, this need not be the case even when the corresponding computer screen interaction region **51** is rectangular in shape. For example, projection region **60** may be spherical in shape. This may cause the projection of a square computer screen interaction region **51** to result in interaction region **71** having the general shape of a sphere-segment. Other shapes are also possible, depending on a number of factors such as the angle between the optical axis of projection device **40** and projection region **60**. It will be appreciated by those skilled in the art that set P (see FIG. **4**, step **90***a* and FIG. **11**, step **120***a*) and method M (see FIG. **6**, step **110***b*) may become more complicated under these circumstances, but may still be well defined. In fact, method M and sets P, A, B may be constructed in any way that is advantageous to the particular system application. It is also possible to determine more points and associated line sets than just CA and CB, and associated line sets A and B. Specifically, set P may have more or fewer than the number of points described with reference to the foregoing embodiments, depending on the complexity of the presentation venue. Also, sets A and B may contain more lines than the minimum number needed to establish the coordinates of the points in set P.

The present invention may make use of mathematical techniques not described explicitly herein but well known to those skilled in the art to aid with various aspects of the present invention, for example in the determination of position and/or orientation of interaction structure **72**. The second example of the first embodiment, for example, was described as relying on three lines highlighting corners of the interaction structure **72**. It is also possible that a more accurate solution for the position and/or orientation of interaction structure **72** may be obtained when the user is requested to also highlight the fourth corner of the screen. An appropriate minimization routine may then be used to find a solution characterized by, for example, a minimum accumulated distance between the four corners of interaction structure **72** and the closest highlighting line.

Moreover, although set P is described as containing points that are needed to completely define interaction structure **72**, other embodiments of the invention may use so-called “control points” for quality control purposes. Such control points may be used to test the validity of the assumptions made concerning, for example, the shape, the position, size and/or orientation of interaction region **71** and, therefore, interaction structure **72**, as well as to test the accuracy of the measurements made to establish the 3D features of the various lines. As an example, consider the case in which interaction structure **72** is taken to be a rectangle for which all data needed to uniquely establish its size, orientation and position with

respect to the x y z coordinate system has been ascertained by the program elements described with respect to the foregoing embodiments. Moreover, in this example interaction region **71** and, therefore, interaction structure **72**, are assumed to substantially coincide with the projection of a rectangular computer screen interaction region **51**. Then, the computer may display a suitable screen mark **521***a*, **521***b*, . . . at, for example, the center of computer screen interaction region **51**, which may be projected by projection device **40** onto projection region **60**. It will be appreciated that the process elements described herein may be used to calculate 3D coordinates of this projected point, based on the available data regarding shape, size, orientation and position of interaction structure **72**. The user may then be required to highlight the projected point using light-beam projection device **202** and indicate the success of this action to the computer by, for example, activating button **203***a*. If all measurements and highlighting actions were accurate enough and no false assumptions were made, the 3D coordinates of the projected point should substantially conform to the 3D characteristics of the z'-axis. If the discrepancy is deemed too large the user may be required to repeat part or all of the calibration steps outlined in the present invention.

There may also be more than one method M and sets P, A and B, each of which may be associated with a different interaction structure **72** and interaction region **71**. There may be more than one interaction structure **72** and interaction region **71**, each of which may, but need not, lie on projection region **60** and each of which may, but need not, be associated by means of projecting screen marks **521***a*, **521***b*, . . . , with one or more computer screen interaction regions **51**.

Although coordinate sensing device (**201** and **301** in FIG. **1**.) were in some embodiments described as being able to provide information on the 3D position and 3D orientation of pointing device (**20** in FIG. **2**) relative to the x y z coordinate system, it should be understood that such information provision requirements may be relaxed under some circumstances. Specifically, in the first embodiment it is only required that the 3D position and 3D orientation of pointing line (**21** in FIG. **2**) to be known, instead of having complete information on the position of pointing device (**20** in FIG. **2**) along the pointing line. That is, in some cases pointing device may be moved along pointing line without loss of functionality. In such embodiments the coordinate sensing devices need only provide information on the 3D position and 3D orientation of a line (as opposed to a line-segment) substantially intersecting pointing device. If coordinate sensing devices are able to provide complete 3D information (i.e., 3D position and 3D orientation) of pointing device, as opposed to pointing line, the extra positional information may, for example, be used to implement the capability to zoom in on a region around point-of-aim (**210** in FIG. **2**); other actions may also be based on the extra positional information. The foregoing capability may be inferred from the description of the third embodiment, in which the coordinate sensing device only is used to provide information on the angle between the pointing line and two other fixed lines, instead of full position and orientation information about a line segment.

Although the first, second and third embodiments describe the application of the invention as a cursor control device, the invention may also be used to facilitate non-cursor-related applications. Such applications may include “virtual writing” on the interaction region **71**, target practice and the like. Also, the invention may be used other than for presentations. For example, methods of the invention may be employed to control a cursor on a television screen in order to make selections

from menus associated with such things as Digital Satellite Television; other applications may also be anticipated.

Moreover, the features of the present invention that enable the tracking of point-of-aim relative to an interaction region may be enhanced by algorithms that allow the filtering of involuntary, fast and/or small hand-movements (that may be caused, for example, by the activation of buttons). Such algorithms may be used to control a point that moves less erratically than the actual point-of-aim while still being associated with it. Such motion filtering may produce a more steady motion of cursor **501**. Such algorithms may also be used when the user is required to highlight calibration points **721***a*, **721***b*, ... Filter algorithms are well-known in the art.

The present invention also contemplates the inclusion into pointing device **20** or presentation device **25** of sensors capable of detecting motion or acceleration, both linear and angular, in addition to or as part of coordinate sensing device **201**. Such sensors may be used to detect unintended motion or acceleration of pointing device **20** or presentation device **25** that may be caused, for example, by trembling of the user's hand. The programs described above with reference to FIGS. **5**, **6**, **12** and **14** may be enhanced by algorithms that compare the output of such sensors and/or coordinate sensing device to predefined thresholds, so that a change in measured orientation and/or position by coordinate sensing device **201** may be recognized as significant only if such output exceeds these thresholds. Using threshold selection, a change in cursor position may only be affected if inferred to be intentional, avoiding the type of "jitter" associated with the use of regular laser pointers by a user with an unsteady hand.

Furthermore, pointing device **20** may be equipped with an image capturing device, such as a digital camera, preferably with zoom and controllable focus capabilities. Other image capturing devices, in combination with appropriate optical devices, may also be used. As stated before, such a digital camera may be used as an embodiment of distance measuring device **206**. Referring to FIG. **18**, such a digital camera or the like (not shown) may also be used to aid in the process of highlighting the calibration points **721***a*, **721***b*. "'Images of calibration points **721***a*, **721***b*, . . . and light spots at point-of-aim **210** may be captured during the time when the user is engaged in the highlighting process. These images may be temporarily stored, together with the position and orientation of the z'-axis at the time the image was acquired. During the highlighting process, it is likely that point-of-aim **210** changes slightly. The resulting sequence of images may then be used to more accurately estimate the orientation and position of the pointing line **21** that connects the origin of the x' y' z' system to calibration point **721***a*, **721***b*, ... For example, an averaging algorithm may be used. Alternatively, the stored position and orientation of the z'-axis corresponding to the captured image for which the light spot at point-of-aim **210** is closest to the center of calibration point **721***a*, **721***b*, . . . may be taken as the position and orientation of the pointing line **21** that connects the origin of the x' y' z' system to calibration point **721***a*, **721***b*, ...

Some features may also be omitted without affecting the overall applicability of the present invention. For example, level-sensing device (**303** in FIG. **1**) and visible markings (**302** in FIG. **1**) may be helpful but are not of critical importance and may be omitted. If level-sensing device **303** are present, the output may also be utilized to correct the orientation of the x y z coordinate system to ensure that its x-y plane is substantially horizontal, as previously explained. In such a case, the visible markings **302** may no longer precisely indicate the position of certain coordinate planes or even the origin of the x y z coordinate system. If the orientation of the uncorrected x-y-plane with respect to a horizontal surface is small enough, though, visible markings **302** may still provide sufficiently reliable information on coordinate planes and origin of the corrected x y z coordinate system.

Furthermore, the programs outlined in FIGS. **3**, **4**, **5**, **6**, **11**, **12**, **14** and **17** may be changed appropriately without loss of functionality, particularly with respect to the order of some of the elements. The programs may also be written in any language that is advantageous to particular the implementation, including without limitation C, Java, and Visual Basic.

Other embodiments that include automatic activation and de-activation of light-beam projection device **202**, or include provision for instructing the cursor control routines to show or hide computer cursor **501** are also within the scope of the present invention. For example, automatic activation and de-activation of light-beam projection device **202** may occur depending on whether or not the z'-axis intersects one of the interaction structures **72**, or regions of space close to them. This may be performed by instructions to the cursor control routines to show or hide computer cursor **501**. Also, means may be provided to activate light-beam projection device **202** manually.

Furthermore, pointing device **20** and presentation device **25** may include a conventional, indirect pointing device such as a trackball or the like, to be used in situations where direct pointing is not possible or not desired. As a practical matter, coordinate sensing device **201**, in some embodiments in combination with coordinate sensing device **301**, may be used to affect cursor control in an indirect manner if the intended use makes this desirable. To effect cursor control in indirect pointing applications, pointing device **20** or presentation device **25** may include a user input, device that enables the user to select whether indirect cursor motion control is desired, or may include sensors and/or algorithms that enable determining when direct pointing actions are not possible. For example, an algorithm or sensor may be included that enables determination of whether pointing device **20** or presentation device **25** is within the operational range of base station **30**. The third described embodiment, specifically, may be enhanced with algorithms and/or sensors, such as accelerometers, that enable to determination of whether pointing device **20** or presentation device **25** have been displaced significantly from the position at which the calibration procedure was performed, making direct pointing actions no longer possible without additional calibration steps. As part of the third described embodiment, additional input devices and algorithms may be included that enable the user to mark an orientation in space such that indirect cursor motion control may be effected based on the changes in orientation with respect to this marked orientation, as described in the cited prior art. Other embodiments of a system may also be enhanced by such functionality and input devices.

In addition to the previously described methods to determine size, position and orientation of interaction region **71**, other methods are also within the scope of the invention. These include methods based on the use of digital cameras and the like. The position and orientation of such cameras, relative to the x y z coordinate system, may be tracked by using a device such as coordinate sensing device **201** and **301**. For example, given sufficient knowledge of the optical characteristics of a digital camera, 3D features of an object may be determined from one or more images taken from one or more positions. Using such images, a complete 3D description of interaction region **71** may be determined.

Another alternative for establishing 3D position, size and orientation of interaction region **71** is provided by a digital camera or the like used in addition to, or as embodiment of,

the distance measuring device **206**. In such embodiments the direction relative to the x' y' z' coordinate system of the axis along which distance is measured may be controlled and measured by mounting the digital camera and/or distance measuring device **206** in such a way that their orientation relative to the x' y' z' coordinate system may be controlled and measured. Other implementations in which the foregoing components are positionally fixed are also contemplated. For purposes of explanation, the axis along which distance is measured is denoted as the z"-axis, and the z"=0 position is assumed to coincide with the origin of the x' y' z' coordinate system. The orientation of the z"-axis with respect to the x' y' z' coordinate system, and also with respect to the x y z coordinate system may therefore be assumed to be known. In this embodiment, calibration points **721***a*, **721***b*, . . . may be displayed simultaneously, as projections of screen marks **521***a*, **521***b*, . . . , and may differ in appearance, such that they may be distinguished by image processing software. Alternatively, calibration points **721***a*, **721***b*, . . . may appear as projections of screen marks **521***a*, **521***b*, . . . in an automatically controlled sequence. The user may then be queried to direct pointing device **20** in the general direction of interaction region **71** in such a way that the digital camera may image the calibration point under consideration. An automated calibration sequence may then be executed, wherein the z"-axis is directed, in sequence, to calibration points **721***a*, **721***b*, . . . etc. The image processing software may identify the various calibration points **721***a*, **721***b*, . . . and the 3D position of these points may then be determined from knowledge of the orientation of the z"-axis and the coordinates of the z"=0 position with respect to the x y z coordinate system, in addition to the measured point-of-aim-distance **211** between the calibration points **721***a*, **721***b*, . . . and the origin of the x' y' z' coordinate system. This embodiment may also provide light-beam projection device **202** mounted in a way that enables control of the direction of the light-beam relative to the x' y' z' coordinate system. This light-beam may be used to aid in positioning the z"-axis. Embodiments where light-beam projection device **202** are fixed or left out entirely are also contemplated.

The present invention also contemplates situations in which parts of the calibration procedures outlined may be repeated at appropriate times. For example, when the relative position of base station **30** and interaction region **71** changes substantially there may be a need to recalibrate the system. Such may also be the case when the position with respect to interaction region **72** of pointing device **20** or presentation device **25** changes significantly, while operation of a particular embodiment of the invention operated using the assumption that such position remains substantially unchanged. As another example, coordinate sensing device **201** and/or coordinate sensing device **301** may include time-integrated acceleration measuring devices. In such a case accuracy of coordinate sensing may deteriorate over time, because of drift in the base acceleration measurements. When the deterioration has become large enough to be unacceptable to the user, the user may be queried to place pointing device **20** in certain deemed positions with respect to the x y z coordinate system, so as to re-initialize coordinate sensing device **201** and **301**.

The present invention also contemplates the use of a plurality of pointing devices **20** and/or presentation devices **25**. Each of the plurality of pointing devices **20** or presentation devices **25** may be uniquely identifiable by the computer, for example by carrying a unique ID code inside their respective communication and control device **204**. Each of the plurality of pointing or presentation devices may be associated with a specific cursor and/or a specific interaction region **71**. For example, a first pointing device may be used to control a corresponding cursor on the left-hand one of two interaction regions **71**, and a second pointing device may be used to control a corresponding cursor on the right-hand one of two interaction regions **71**. Alternatively, both pointing devices may be used to control a corresponding, identifiable cursor on the same interaction region **71**.

Furthermore, the present invention contemplates the use of a plurality of entities such as base station **30**, a particular one of which may be associated with the origin of the x y z coordinate system. Such a base station may be designated as the 'master base station'. Each of the base stations may include coordinate sensing device **201**, so that their respective position and orientation relative to the master base station can be determined with greater accuracy than that afforded by the coordinate sensing device **201** that is incorporated in pointing device **20**. Using such multiple base stations and coordinate sensing devices, 3D data pertaining to pointing device **20** may be determined relative to the closest base station, and the relative position and orientation of that base station with respect to the master base station may be used to establish the 3D data pertaining to pointing device **20** with respect to the x y z coordinate system. Alternatively, signals from multiple base stations, as measured by the coordinate sensing device **201** disposed in pointing device **20**, may be used simultaneously to reduce measurement errors. Generally speaking, determining the 3D data pertaining to pointing device **20** with respect to the x y z coordinate system by making use of only one base station **30** may be less accurate than by making use of a plurality of base stations. Hence, the effective range' of operation of pointing device **20** may be enhanced by distributing a plurality of base stations over a large region of space.

Referring to FIG. **19**, in another embodiment, different devices than light-beam projection devices may be used to determine the position of the points in set P. For example, light-beam projection device **202** may be omitted in an embodiment where pointing device **20** has the general shape of an elongated body, such as a pointing stick. The length of this stick may be predetermined or variable. For example, pointing device **20** could be in the shape of an extendible, or telescopic pen such as the INFINITER Laser Baton sold by Bluesky Marketing—Unit 29, Six Harmony Row, Glasgow, G51 3BA, United Kingdom. The process of highlighting a calibration point **721***a* **721***b*, . . . , in this embodiment may be replaced by the action of pointing to the calibration point **721***a*, **721***b*, . . . , thereby guided by the elongated shape of pointing device **20** instead of the light spot shown in FIG. **18** at point-of-aim **210**. Distance measuring device **206** may also be provided in a related embodiment, similar to the second described embodiment. For example, distance measuring device **206** may include a device to measure the distance from the tip of the elongated body of pointing device **20** to the origin of the x' y' z' coordinate system. In such an embodiment, in order to obtain measurements of point-of-aim distance **211**, as described for example at program element **130***f* (see FIG. **12**), the user might be queried to make physical contact between the tip of pointing device **20** and the calibration point. Referring to FIG. **19**, pointing device **20** may also comprise contact-sensing device **207**, for example at the tip of pointing device **20**, capable of indicating physical contact between the tip of pointing device **20** and a surface. Contact-sensing device **207** may be in the form of a pressure-sensor or switch. Such sensors are known in the art.

The present invention also contemplates the use of various other sensors integrated in pointing device **20**, presentation device **25** and/or base station **30** to help determine the position and/or orientation of interaction structure **72**. For example, pointing device **20**, presentation device **25** and/or

base station **30** may include ultrasonic emitting and detecting devices to enable measuring substantially the shortest distance between a known point in the x y z coordinate system (e.g., the position of pointing device **20**; of presentation device **25** or of base station **30**) and the plane in which projection region **60** lies. The user may be queried to align pointing device **20**, presentation device **25** or base station **30** such that the distance measuring device is oriented substantially perpendicularly to projection region **60**. It should be understood that other types of sensors may be included in pointing device **20**, presentation device **25** or base station **30** to help constrain the position and/or orientation of interaction structure **72**.

In some cases it may be unnecessary to provide a separately embodied base station **30**. For example, coordinate sensing device **201** may partly or completely rely on inertial sensing means such as accelerometers and gyroscopes, or on distance measurements with respect to walls, ceiling and/or floor. In such cases it would be possible to leave out base station **30** entirely and simply choose an appropriate x y z coordinate system. In such embodiments communication and control device **204** could be configured to communicate directly with the computer.

The present invention also contemplates the use of automated procedures to establish the nature of the calibration points **721***a*, **721***b*, **721***c*, **721***d*, based on the measurements of the orientation and/or position of the pointing lines **21** that substantially pass through them. For example, with reference to FIG. **7**, calibration points **721***a* and **721***d* need not be explicitly identified to the user as upper-right and lower-left corner respectively, but may merely be identified as diagonally opposite corners. Those skilled in the art will appreciate that in such a case an automated procedure may use the measurements of orientation and/or position of both pointing lines **21**, specifically with respect to the x-y-plane, to identify which of the two lines passes through the upper one of the two diagonally opposite corners. The practical consequence to the user is that the user need not be concerned about which of the two calibration points **721***a* and **721***d* is highlighted first. Similar arguments can be used to construct automated procedures that determine whether a pointing line **21** substantially passes through a left or a right corner of interaction region **71** (and, by assumption, of interaction structure **72**). For example, the a priori assumption may be made that the clockwise angle between a pointing line **21** through a left corner and a pointing line **21** through a right corner, measured parallel to the x-y-plane, should not exceed 180 degrees, as will be appreciated by those skilled in the art.

Finally, although the methods disclosed by the present invention are described in 3D, the invention may also be applied in 2D scenarios.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. An apparatus for controlling a feature on a computer generated image, the apparatus comprising:

a handheld device including:

an image sensor, said image sensor generating data related to the distance between a first point and a second point, the first point having a predetermined

relation to the computer generated image and the second point having a predetermined relation to a handheld enclosure; and

a processor coupled to said handheld device to receive said generated data related to the distance between a first point and a second point and programmed to use the distance between the first point and the second point to control the feature on the image.

2. The apparatus of claim **1**, wherein said processor is programmed to determine the distance from said generated data related to the distance.

3. The apparatus of claim **1**, wherein said handheld device further includes:

at least one sensor generating data related to the orientation of said handheld device, and

wherein said processor is further programmed to use the generated data related to the orientation to control the feature on the image.

4. The apparatus according to claim **1**, wherein calibration points are provided in a predetermined relationship to the image,

wherein said image sensor detects the calibration points and generates data including data of the calibration points, such data being calibration data, and

wherein said processor is programmed to use said calibration data to control the feature.

5. An apparatus for controlling a feature on a computer generated image, there being calibration points provided in a predetermined relationship to the image, the apparatus comprising

a handheld device including:

an image sensor, said image sensor generating data including data of the calibration points; and

a processor coupled to said handheld device to receive said generated data including data of the calibration points and programmed to use said generated data including data of the calibration points to control the feature on the image.

6. The apparatus of claim **5**, wherein said handheld device further includes:

at least one sensor generating data related to the orientation of said handheld device, and

wherein said processor is further programmed to use the generated data related to the orientation to control the feature on the image.

7. An apparatus for controlling a feature on a computer image, the apparatus comprising:

a handheld pointing device having a predetermined relation to a pointing line, said pointing line passing through said handheld pointing device;

a position sensor generating data indicative of at least part of the position of said handheld pointing device along said pointing line when said pointing line is also passing through the image; and

a processor coupled to said position sensor to receive said generated data and programmed to use said generated data to determine the position of said handheld pointing device along said pointing line with relation to the image and to use said position of said handheld pointing device along said pointing line with relation to the image to control at least one aspect of the feature.

8. The apparatus of claim **7**, wherein said at least one aspect controlled includes zoom level of the feature.

9. A method for controlling a feature on a computer generated image, the method comprising:

generating data related to the distance between a first point and a second point by an image sensor in a handheld

device, the first point having a predetermined relation to the computer generated image and the second point having a predetermined relation to the handheld device;

determining the distance between the first point and the second point using the generated data related to the distance between the first point and the second point; and

controlling the feature on the image based on the distance between the first point and the second point.

10. The method of claim **9**, further comprising:

generating data related to the orientation of said handheld device using at least one sensor in the handheld device; and

controlling the feature using the generated data related to the orientation.

11. The method according to claim **9**, wherein calibration points are provided in a predetermined relationship to the image, the method further comprising:

detecting the calibration points by the image sensor and generating data including data of the calibration points, such data being calibration data, and

controlling the feature using said calibration data.

12. A method for controlling a feature on a computer generated image,

there being calibration points provided in a predetermined relationship to the image, the method comprising:

generating data including data of the calibration points by an image sensor in a handheld device; and

controlling the feature on the image based on the generated data including data of the calibration points; wherein said handheld device further includes, generating data related to the orientation of the handheld device by at least one sensor in the handheld device; and controlling the feature on the image using the generated data related to the orientation.

13. A method for controlling a feature on a computer image, the method comprising:

generating data indicative of at least part of the position of a handheld pointing device along a pointing line having a predetermined relation to the handheld pointing device, said pointing line passing through the pointing device and the pointing line also passing through the image;

determining the position of the handheld pointing device along said pointing line with relation to the image; and

controlling at least one aspect of the feature using said position of the handheld pointing device along the pointing line with relation to the image.

14. The method of claim **13**, wherein said at least one aspect controlled includes zoom level of the feature.

* * * * *

PROOF OF SERVICE

I hereby certify that on March 30, 2015, I filed the foregoing ***Plaintiff-Appellant's Principal Brief (Nonconfidential)*** through this Court's CM/ECF system. Pursuant to this Court's Administrative Order Regarding Electronic Case Filing (May 17, 2012), ECF-6, the Notice of Docket Activity generated by this Court's CM/ECF system constitutes service of the document on the ***Appellees*** because they are represented by the following attorneys who have registered for the CM/ECF system:

Jerry A. Riedinger
Tyler C. Peterson
Perkins Coie LLP
1201 Third Avenue, Suite 4900
Seattle, Washington 98101

Richard Salgado
Mark Christopher Nelson
Steven M. Geiszler
Dentons US LLP
2000 McKinney Avenue, Suite 1900
Dallas, Texas 75201

/s/Charles J. Rogers
Charles J. Rogers
Conley Rose, P.C.
1001 McKinney Street, Suite 1800
Houston, Texas 77002-6421
Telephone: (713) 238-8049
Facsimile: (713) 238-8008
E-mail: CRogers@conleyrose.com

Principal Attorney for
Plaintiff-Appellant
UltimatePointer, L.L.C.

CERTIFICATE OF COMPLIANCE
WITH TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE REQUIREMENTS

1. This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B), because it contains 13,368 words, excluding the parts of the brief exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii) and Federal Circuit Rule 32(b).

2. This brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6), because it has been prepared in a proportionally spaced typeface using Microsoft Word 2010 in Times New Roman 14 point font.

Dated: March 30, 2015

/s/Charles J. Rogers

Charles J. Rogers
Conley Rose, P.C.
1001 McKinney Street, Suite 1800
Houston, Texas 77002-6421
Telephone: (713) 238-8049
Facsimile: (713) 238-8008
E-mail: CRogers@conleyrose.com

Principal Attorney for
Plaintiff-Appellant
UltimatePointer, L.L.C.